THE GLASS INDUSTRY

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RADIANT HEAT IN THE GLASS INDUSTRY

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The glass industry's increasing use of radiant gas heating has been responsible for additional gains in shortening heating cycles and improving product quality. Advantages of this relatively new working tool include production increases, fuel savings, reduction in equipment size, and decreased loss of ware.

Throughout all industry, heating engineers have attempted to reduce fuel requirements, time cycles, and equipment sizes toward theoretical minimum. In many fields this effort has been notably successful. The old rule of thumb that steel to be hardened should be heated one hour per inch of thickness has been discarded almost everywhere, and the same material is now heated for forging in minutes. High speed ink drying now permits fine quality four-color printing on coated paper, in a single pass through the presses. New enamels are now completely baked in one-tenth the former time. Tubular heaters and steam boilers are built to only a fraction of their former sizes.

In contrast to the foregoing accomplishments, much heating equipment in the glass industry has remained bulky, time cycles are generally long, and fuel requirements usually high. Theoretical glass annealing cycles can be computed from accepted formulas, but often are shorter than commercial annealing cycles by ratios greater than one to ten. When commercial cycles are long, equipment size and fuel requirements usually must be proportionately large. Table I shows theoretical and actual heating time requirements for two types of glass, and Figure 1 shows comparative time-temperature curves for one of these types. Both have been taken from H. K. Richardson's address before the American Ceramic Society, as published in their *Bulletin* of January 15, 1950.

In fairness to the glass industry, it must be realized that their materials are difficult to heat. Common glass is a relatively poor heat conductor and is susceptible to breakage from uneven thermal stresses. Always a major problem, loss from this cause is one form of "shrinkage"—an industry term meaning loss of ware during production, from whatever reason. It is the attempt to minimize "shrinkage" that has always been responsible for prolonged heat treating cycles. These long cycles and small temperature differentials have served a purpose in minimizing strains within the ware.

During recent years, forced convection has been popular as a uniform heating method, employing relatively low thermal differentials and high rates of air flow, well distributed. Most glassware, however, has *non-uniform* heat requirements. For example, to bring a heavy section to the same temperature requires more heat for the heavier part. If typical convection heating is used, the thin section rises in temperature faster than the heavy section. The differential thermal expansion which results creates additional strain in the ware. This, of course, increases both likelihood of "shrinkage" and the burden on annealing equipment. Eventual uniform temperatures must be obtained by prolonged "soaking" at heat.

The alternative method is what might be called *proportional*, or *pattern heating*. In this method, heat is transferred in a manner which permits each section of the ware to receive it at a rate more nearly proportional to its particular requirement. Where this is successful, fewer strains are developed, and all parts of the ware reach the same temperature more quickly.

To recognize and accomplish this objective required a new approach to heating glass, and obviously a new heating method was also necessary. For the requirements of proportional heating, the radiant gas burner is well suited. Patterned arrangements of these burners permit heat sources to be matched with heat requirements. Radiant energy has the highest transfer rates and is free from the retarding effects of transparent surface films. Of particular significance is the fact that these burners release part of their heat within the glass itself, as will be explained later.

Radiant Burner Construction and Operation

Many types of radiant gas burners are in use today. Although luminous flame and certain "atmospheric"

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Table I.

OPERATION	LOW EXPANSION (BOROSILICATE) 3/8 INCH THICK		LIME GLASS - (90 x 10⁻⁷ coef.) 1/8 INCH THICK	
	THEORETICAL	COMMERCIAL	THEORETICAL	COMMERCIAL
PREHEAT FROM INITIAL CONDITION TO TEMPERATURE LOG 13.0	1.0	41.0	0.5	2.0
SOAK AT LOG TEMPERATURE 13.0 (INSTANTANEOUS ANNEALING POINT)	2.0		0.5	
ANNEAL THROUGH CRITICAL RANGE LOG 13.0 TO STRAIN POINT	10.0	29.0	0.6	10.0
COOLING FROM STRAIN POINT TO HANDLING TEMPERATURE	9.0	170.0	0.4	20.0
TOTAL	22.0	240.0	2.0	32.0

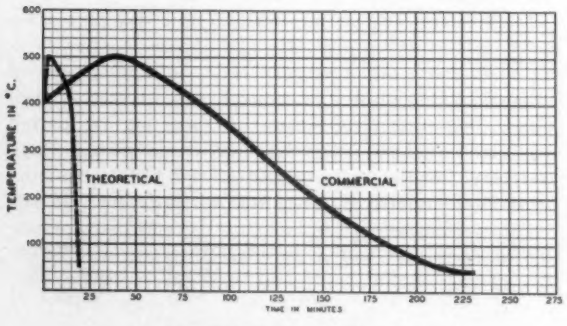
COMPARISON OF ANNEALING CYCLES IN MINUTES THEORETICAL VS. COMMERCIAL OF GLASSES SHOWN

burners can also be classed as radiant, this discussion will be limited to those whose radiant energy is developed by forcing carefully proportioned and compacted gas-air mixtures along refractory surfaces, where combustion heats those surfaces to incandescence. These burners are available in many styles and capacities and may be used in the open or built into heating panels or furnace brickwork.

Figures 2 and 3 show two types of radiant gas burners, for open or for enclosed applications, respectively. Gas-air mixture enters through tube 1, passes then through multiple slots of burner tip 2, and burns against the incandescent refractory surface of cup 3. Intimate contact between incoming gases and the hot refractory accelerates the combustion reaction. With proper adjustment, flames are confined within the cup. Figure 4 shows an apparently flameless radiant burner with a conventional tunnel burner operating on the same mixture and burning with the same rate of input. The absence of protruding flame has made this radiant burner very popular for use in close proximity to work which suffers from flame contact.

Ceramic materials used in radiant burners are numerous, and should be selected for the particular application to give the best combination of high radiant emission, long life, low heat storage, and low thermal conductivity. Where high temperatures will be experienced, the usual metal parts can be replaced by alloy or all-ceramic construction. Because of the small diameter or width of individual ports and flame retaining qualities of hot refractories, most radiant burners possess wide turndown qualities.

Accurate gas-air ratio control is important because excess of either gas or air will reduce burner temperature. Furthermore, combustion equipment for the previously described "pattern heating" should be such as to permit turning individual burners down or entirely off without affecting gas-air ratio in other burners. In this way proper pattern adjustment can be made to suit the work being heated.



GRAPHIC COMPARISON OF ANNEALING CYCLES. THEORETICAL VS. COMMERCIAL FOR LOW EXPANSION BOROSILICATE GLASS 3/8 INCH THICK

Fig. 1.

Radiant and Convected Heat

Radiant burners convert incoming fuel gas energy to useful radiant and convected heat. In addition—as in all gas burners—there is unavailable heat, better known as flue loss. We should think of the radiant burner as a source of all three. One difference from other burners, however, is that in these burners radiant heat accounts for an important part of the total. In well designed glass heating operations, radiant energy is of course first utilized as effectively as possible and then the hot burned gases are employed for additional transfer by convection, frequently for preheating.

Radiant Heat and the Electromagnetic Spectrum

The successful use of radiant heat in the glass industry requires rather careful consideration of the electromagnetic spectrum, which contains in their proper relative positions all of the waves which transfer energy. These, of course, include light and heat rays, X-rays, radio and sound waves, and all the rest. Those in the range in which we are now interested are measured in microns, a micron being one-millionth of a meter.

Figure 5 covers that portion of the electromagnetic spectrum where wavelengths are less than 10 microns. On it is shown a curve indicating the distribution of radiant energy from a typical radiant burner, with maximum emission at this particular temperature at 1.4 microns.

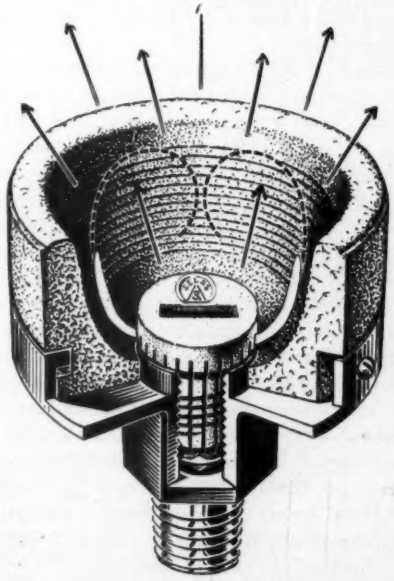


Fig. 2.

Fig. 3.

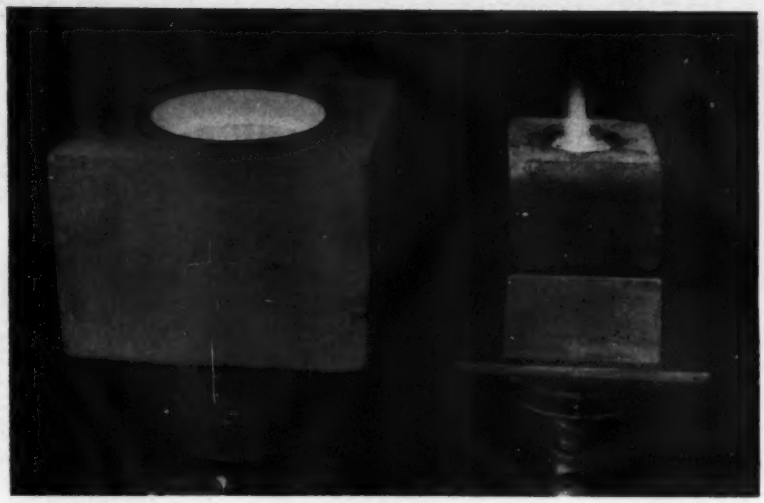


Fig. 4.

The visible light band is the shaded section between .4 and .7 microns, and it is readily seen that most of the burner's energy is invisible, or infrared. Infrared, of course, is merely a name assigned to heat rays as a group. It is not a trade name registered by the electric industry. Included in the group are all heat rays, whether they come from the sun, an incandescent lamp, a radiant gas burner, or a parlor steam radiator. They vary, however, in intensity, and in distribution of wavelengths.

Radiant heat rays both change intensity and redistribute themselves with changes in source temperature. As temperature rises, total radiation increases and shorter wavelengths become those of greatest intensity. As temperature drops, these changes are reversed. This is significant in heating glass, in which reception of radiant heat changes with the wavelengths.

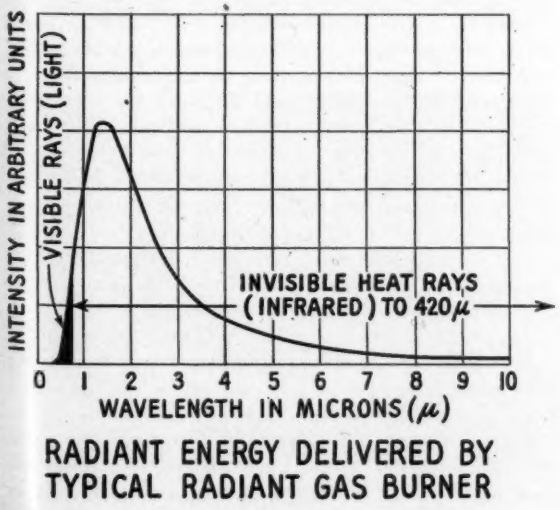

INTENSITY IN ARBITRARY UNITS
VISIBLE RAYS (LIGHT)
INVISIBLE HEAT RAYS
(INFRARED) TO 420μ
0 1 2 3 4 5 6 7 8 9 10
WAVELENGTH IN MICRONS (μ)
RADIANT ENERGY DELIVERED BY
TYPICAL RADIANT GAS BURNER

Fig. 5.

Glass Reflects, Transmits, Absorbs

It has often been implied that heat from radiant burners has mysterious penetrating quality in the heating of metals and other opaque materials. So far as we know, however, heat which reaches the interior of a piece of gas-heated metal arrives there by conduction from the surface. In the heating of glass, however, a different situation exists. We are dealing with a decidedly different group of substances and they must be treated as such.

Properties of glasses vary widely, for there are hundreds of formulas in commercial use today. Some, for example, have high dielectric strength while others readily conduct electricity. Likewise, the reception of radiant heat by glasses varies widely also. Radiant energy may be reflected, transmitted, or absorbed. In the radiant heating of most glass, all three occur together.

Figure 6 shows transmission by three different types of glasses of comparable thicknesses but with different analyses, using wavelengths from 0 to 3 microns. Obviously, where transmission is low, absorption is high. Curve A is for a high clarity glass which passes at least 90 per cent of light rays and most of the infrared up to about 2.6 microns. Curve B is another glass which transmits many of the light rays but absorbs and converts

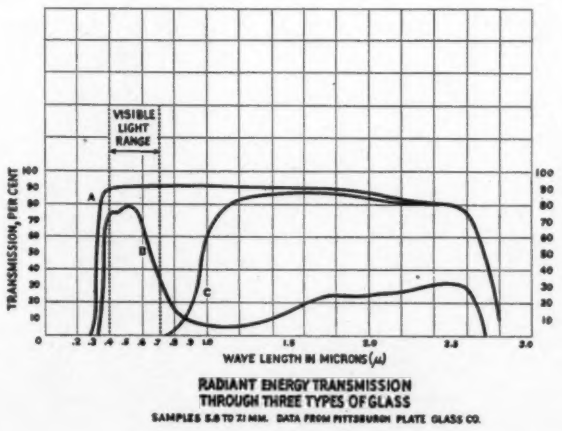


Fig. 6.

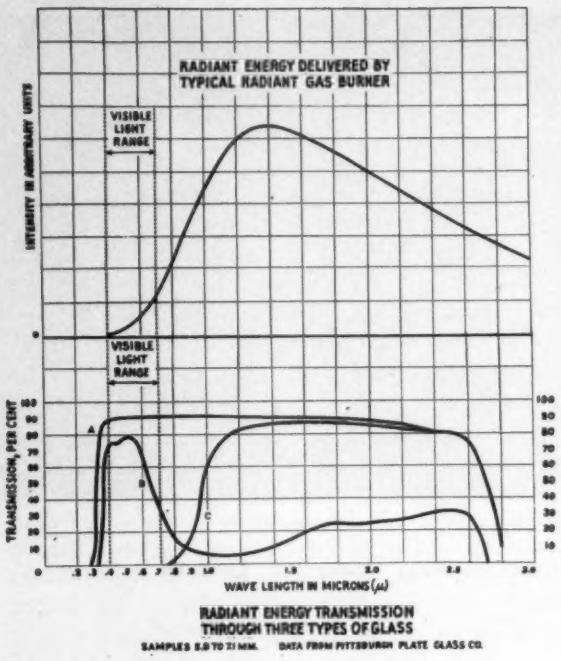

RADIANT ENERGY DELIVERED BY TYPICAL RADIANT GAS BURNER
INTENSITY IN ARBITRARY UNITS
VISIBLE LIGHT RANGE
VISIBLE LIGHT RANGE
TRANSMISSION, PER CENT
A
B
C
WAVE LENGTH IN MICRONS (μ)
RADIANT ENERGY TRANSMISSION THROUGH THREE TYPES OF GLASS
SAMPLES 2.0 TO 2.1 MM. DATA FROM PITTSBURGH PLATE GLASS CO.

Fig. 7.

most of the infrared rays into heat. Curve C, on the other hand, transmits no visible light but passes most infrared rays up to 2.6 microns.

Figure 7 shows these same glass transmission curves plotted with that segment of the radiant burner emission curve which lies in the same range—from 0 to 3 microns. By comparison it can be seen that most radiant heat absorption by glasses A and C takes place beyond 2.6 microns where radiant burner output is not so great. Glass B, however, readily absorbs those heat rays which the burners deliver in greatest quantity. The conclusion reached, of course, is that in the radiant heating of glass, the matter of wavelengths deserves careful consideration.

Advantages of Radiant Heating

It has already been pointed out that infrared energy

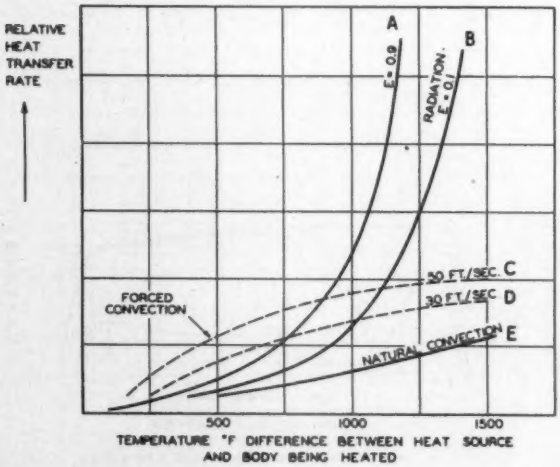


Fig. 8.

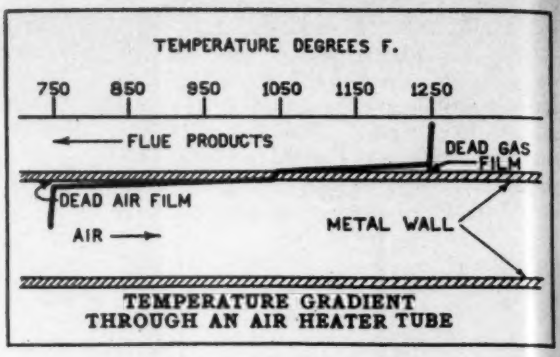


Fig. 9.

comprises only a portion of the output of a radiant gas burner. On-the-job performance, however, has shown that the importance of this radiant energy portion is much greater than is indicated by quantity alone.

Higher Rates of Heat Transfer. It is well known that radiant energy travels in straight lines at a speed of 186,000 miles per second. Speed is not the only consideration, however, because operating temperatures, thermal differentials, and other factors play important roles in determining rates of heat transfer. To provide graphic comparison of transfer rates developed through radiation, forced convection and natural convection methods, Figure 8 has been taken from data compiled at the University of Leeds in England. Curves A and B encompass all of the radiant heat transfer rates from sources with ordinary emissivities. Emissivity is radiating efficiency as compared to that of a "black body" or perfect radiator under the same conditions. Curves C and D indicate convection transfer rates with velocities of 50 and 30 feet/second respectively. Curve E gives comparable data for natural convection.

It will be noted that, when temperature difference between heat source and work exceeds approximately 1000°F., heat is transferred by radiation much more rapidly than by other methods. Operating temperature differentials between glass and radiant burner surfaces are well in excess of this figure.

Independence from Transfer Agents. All convection heat transfer is retarded by the effect of the so-called "dead film". This is an insulating layer of gas or liquid which adheres tightly to solid surfaces and tends to prevent direct contact between heat transfer media (such as heated air, oil, or water) and the solid surface. These films, which will retard heat flow on both sides of the wall, can, of course, be made less effective by increasing flow rates. A clearer comprehension of this film factor may be gained by reference to Figure 9 which has been taken from the 1932 edition of *Combustion*.

Radiant heat waves travel uninhibited through transparent surface films, are not affected by them, and do not require fast moving transfer media.

Transmission and Absorption in Glass. As has already been shown in Figure 6, radiant energy is both transmitted and absorbed by glass in proportions which depend upon wavelengths, glass composition, and glass thickness. Because most glasses are poor heat conductors, any heat released within glass materially reduces the time which would be required for it to creep inward by conduction. Simultaneous external and internal heating

also reduces temperature differentials which are usually a major cause of glass "shrinkage".

Availability of Patterned Heat. Directional control over radiant energy makes it possible to transfer heat in patterns that are matched to work requirements. With radiant gas burners, these patterns are both versatile and adjustable. Except where direct and sharp flame contact with the ware may be tolerated, this is not readily accomplished with other burner types.

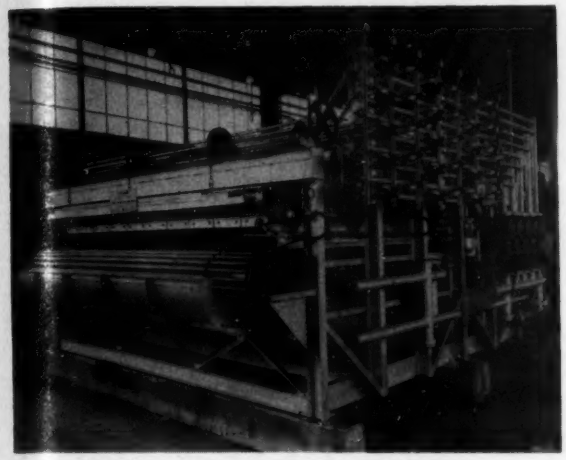


Fig. 10.

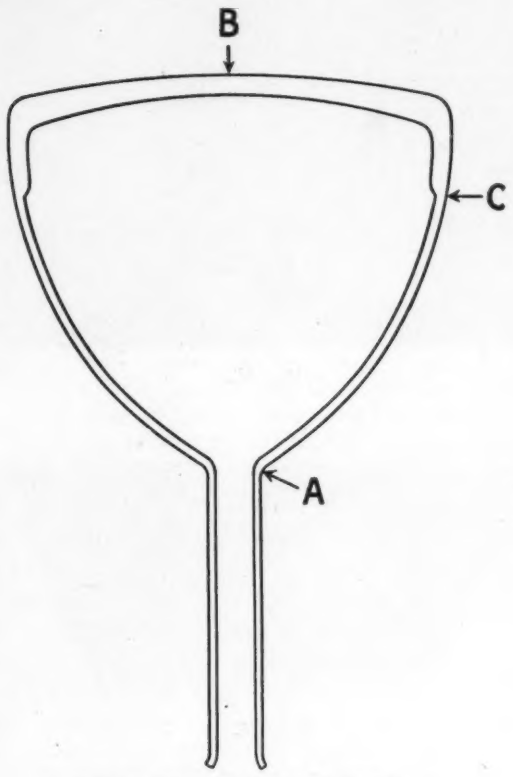
Fig. 11.

Fig. 12.

Outstanding Production Applications

To meet exacting production requirements, specific radiant heat applications have been worked out by glass producers. Calling upon knowledge gained in glass and other industries, numerous radiant heat processes have also been developed by the equipment manufacturer. Further contributions have been made by the industrial gas engineer. Some of these applications have resulted from what might be called thorough analytical studies of basic heating requirements, while others were worked

Fig. 13.



CROSS SECTION OF TYPICAL ALL-GLASS TV PICTURE TUBE

Fig. 14.

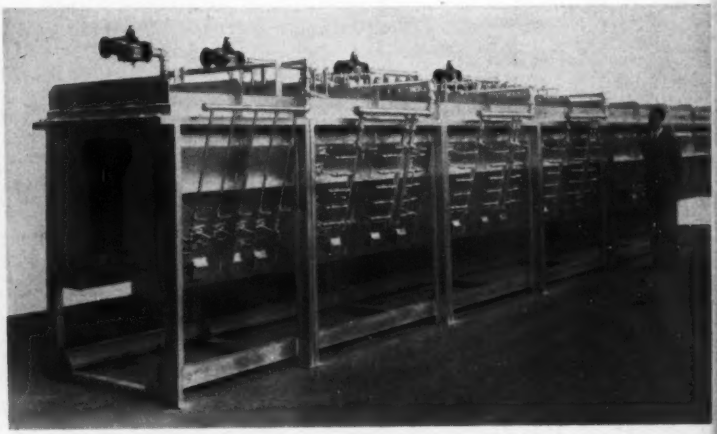


Fig. 15.

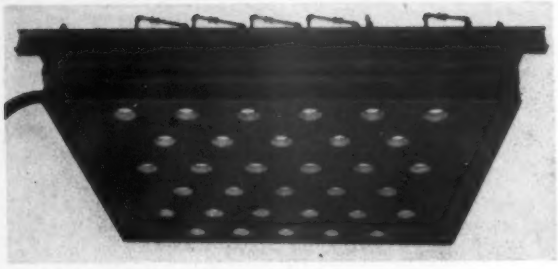


Fig. 16.

out in sheer desperation after all other methods had failed.

New radiant gas heat applications continue to appear, and some of these are so far afield from long accepted conventional practice as to arouse some quite understandable skepticism. Although customer reticence prevents discussion of some of the more interesting uses, enough significant applications may be mentioned at this time to indicate the further possibilities of radiant heat in the glass industry.

Fluorescent Lamp Tube Lehrs. Fluorescent lamp tubes are made in a number of lengths and diameters, but all of them must be heated for baking the interior coating, for straightening, and for annealing. Much of this production is carried out in remarkably short, high speed lehrs. At rates approximating one tube per second, these three operations all take place beneath radiant roofs in "heating machines" like those shown in Figures 10 and 11. Similar lehrs, which permit easy arrangement of radiant roof patterns from operating floor levels, are in use today from Manila to Madrid. In this application, some radiant energy passes through the glass to bake fluorescent coatings from within. Simultaneous external and internal heating shortens cycles, reduces both equipment size and fuel requirements.

Baking Monograms on Lamps. On the top of each incandescent lamp is a small monogram which gives the maker's name and lamp rating. That monogram is fired in what amounts to a local or "spot" heating job. A small round radiant burner permits fast heating at close range, and yet without flame impingement. The reduced transparency of the imprint permits it to absorb radiant heat faster than the glass around it. This method has increased both speed and quality of production. As a result, a leading lamp producer has recently instructed all plants to convert to it.

Tempering Faces of Metal TV Picture Tubes. The use of radiant gas heat in television tube manufacture has been discussed at some length in a recent AGA Information Letter, so will receive only brief mention here.

Where preformed glass picture tube faces are fused to metal tube side walls, it is necessary to temper these

(*Continued on page* 372)

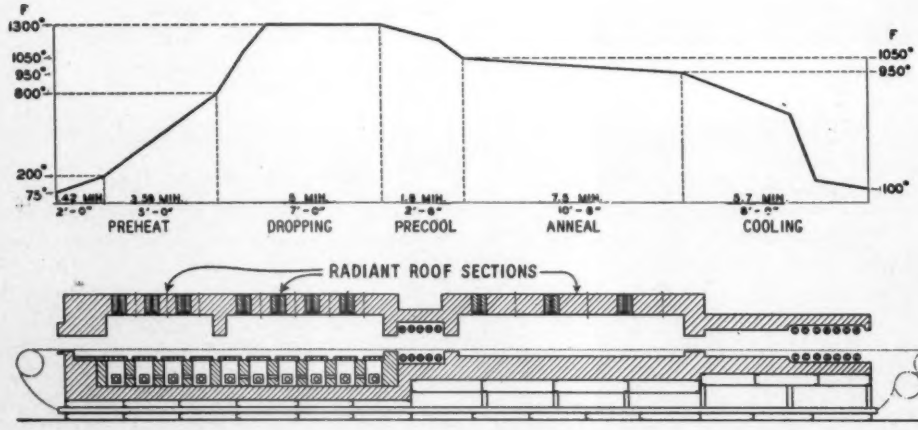


Fig. 17.

LEHR FOR LENS DROPPING WITH TIME-TEMPERATURE CURVE SHOWN.
TOTAL CYCLE 25 MINUTES.

WISE OWL CLUBS SAVE EYES IN GLASS PLANTS

By H. H. SLAWSON

It was work as usual on the Fourth of July two years ago for employees at the Fairmont, West Virginia, plant of the Owens-Illinois Glass Company and among those who routinely punched the clock on the first shift was Charles E. Hogan. As it turned out, however, it was not at all the usual routine day to which Hogan had been accustomed.

Day after day, for longer than he could remember, it had been Hogan's responsibility during his tour of duty, to tap a furnace and up to now he had never encountered any trouble. This time, though, this Independence Day, 1949, something went wrong. As Hogan proceeded with the operation, a stream of molten glass blew out of the trough and struck his safety glasses. What happened immediately we need not further dwell upon. Two sentences, however, from the report of this incident made to the National Society for the Prevention of Blindness are worth attention.

Club Emblem

"If Mr. Hogan had not been wearing the goggles," reads this report, "he would be completely blind today. The goggles saved his eyes from damage."

Then there was Peter Fernandez, a machine foreman in the Oakland, Calif., plant of Owens-Illinois, about whom another report to the NSPB says: "While watching the operation of a glass bottle machine, an unknown object flew off the machine, smashing the left lens of his safety glasses. His eyes were undamaged."

And, too, there was Richard Phillips, who also works in the Oakland plant. One day while Phillips was removing melted bricks from a checker chamber, a piece of hot brick flew out and broke the left lens of his safety glasses. But—lucky man—the eye was undamaged.

If you are not aware of it, those four words—*the eye was undamaged*—have become the password to membership in a unique organization which is spreading swiftly among industrial workers.

As any safety director well knows, factory workers in the past have been all too indifferent to the importance of wearing eye protective devices where eye hazards exist. Recently, however, workers have begun to evidence a new interest in the vitally important matter of protecting their eyes from destruction when engaged in their daily toil.

This revolution in worker attitude is being brought about primarily by making the wearing of goggles while at work a mark of distinction. Effective application of the idea has been achieved by the organization of "Wise Owl" clubs among factory personnel. Eligible for membership are men and women workers who were wearing goggles when something happened that might, otherwise, have destroyed their eyes.

Symbolizing their escape from the "living death" of blindness, they display on coat lapels a pin—a small gold owl wearing large goggles—which, like a Purple Heart decoration in the armed services, proclaims their lucky status.

Hogan, Fernandez, and Phillips of the Owens-Illinois Glass Company are but three of more than 1,000 who now wear the Wise Owl pin. Latest available figures from the National Society for Prevention of Blindness show that, as of October 1, 1950, the club had 1,258 members in 266 industrial plants of all types, employing 396,098 persons. Eyes saved by the movement represent, also, a saving of some $3,000,000 in compensation, which employers would otherwise have been obliged to pay out for injured eyes.

In the glass industry to date, according to the NSPB, only the two Owens-Illinois plants at Fairmont, West Virginia, and Oakland, California, and the Brooklyn, New York, plant of Modern Glass Processing Corp. have joined the procession supporting the new eye saving program.

An interesting story is related of how the idea which has ushered in a new day for workers' eyes was born in the brain of a negro, Joe Folks, for years an employee of American Car & Foundry Co., at St. Louis, Missouri. Working in the chipping and grinding department, Joe had many experiences which taught him the importance of wearing his goggles every moment while on duty.

Knowing full well that others around him were likewise veterans of similar "near misses", it was but natural for Joe to become a "specialist" on goggle wearing and he never passed up an opportunity in the shop, or at his department's safety meeting, to say a word on the importance of observing the company's 100 per cent goggle rule.

Joe knew, too, that at times men were careless and took chances. This disturbed him deeply and while pondering this human weakness at his bench one day, his big idea came to him.

During the last war Folks had heard about the "Caterpillar Club" whose members were airmen who had saved their lives by "hitting the silk" and parachuting to safety when their planes went out of control in combat. Thereafter these heroes were entitled to wear the club emblem, a small gold caterpillar pin, which looked like it was crawling up a man's jacket lapel.

Why not, Joe asked himself, form a club composed of his foundry associates who had saved their eyes because they were wearing goggles at the moment of crisis? To his superiors he presented this idea and the new movement for saving factory workers' eyes was quickly on its way.

The name "Wise Owl Club" was selected, a pin designed, along with a certificate, which were presented in formal ceremonies to the 76 employees immediately found measuring up to the entrance requirements. In the following two years membership among this company's various plants grew to 180 and then American Car & Foundry Co. made its plan available to the National Society for Prevention of Blindness, by which, since 1949, the movement has been promoted on a nation-wide basis.

At the Owens-Illinois plant in Fairmont, West Virginia, the management considers the Wise Owl Club "one of our most valuable assets in the prevention of eye injuries", says C. R. Judy, Personnel Director He tells of

two other odd accidents which illustrate the wisdom of wearing eye protectives, not merely in production departments but in any area throughout the plant.

One happened to Leo Newton, a warehandler in the shipping department, who was struck by a toppling carton which broke the frame of his safety glasses. If Newton had been wearing any ordinary spectacles, they would have been shattered. But, since they were safety glasses, his eyes were saved from injury.

Another charter member of the Owens-Illinois chapter, as related by Mr. Judy, is Cecil M. Carroll who, on his first day of duty as a watchman, was detaching the American flag which flies daily over the plant. A strong wind caused the rope to whip around and the heavy shackle struck the frame of Carroll's prescription safety glasses, just above the right eye. The frame was smashed, but the force of the impact was taken up and there was no eye injury.

"Our medical and safety services worked together to get the Wise Owl Club plan started," reports Mr. Judy. After all, establishment of the Wise Owl Club was just another extension of the safety program which Owens-Illinois pioneered many years ago. Eye protection has always been an important phase of Owens-Illinois' program, and one which received constant promotion. All Owens-Illinois employees are required to view the company's eye protection film entitled, "Your Richest Gift".

"As a result of its consistent and careful attention to employee safety, Owens-Illinois has enjoyed a fine record for reducing man-hours lost through injury. Our plant manager, department heads, foremen, and welfare council all joined in helping to search for eligible charter members and in promoting the Club. Our plant newspaper, *The Fairmont Echo*, and our medical service publication, *Safety Facts*, carried the message of the Wise Owl Club to the people."

Wise Owl Club posters were displayed throughout the plant, he continued, and for the Christmas holiday season the medical department prepared an exhibit featuring the Wise Owl in fairyland. In a Hansel and Gretel setting, a boy and girl made of cookie dough were returning from a forest to a candy-and-icing thatched cottage, along a colored sugar path carefully marked with red candy. Nearby a cookie cat sat on a striped peppermint fence. Watching over all, atop a cotton covered plastic tree was the Wise Owl with green Lifesaver eyes.

"The display was placed in a case located at the plant's front entrance and attracted much attention," said Mr. Judy. "Its allegorical representation of the two little children who might have been lost, but were saved by foresight, helped acquaint our people with the Wise Owl Club and its relation to their precious and irreplaceable eyes."

The factory superintendent who can boast that in any given year not one of his employees suffered a disabling eye injury can well consider himself extremely lucky. National Safety Council figures indicate that each year, one out of 575 industrial workers suffers an accidental eye injury on the job. A national health survey covering one full year revealed that 8,000 persons had lost both eyes in occupational accidents and about 80,000 lost one eye. Safety Council files, too, contain a study of 237 cases of eye infection, including two which brought death to two men.

It is hard to understand, but there actually are working men (and women) who would rather not work than wear goggles. Sometimes it is a case of pure carelessness or indifference, which can be corrected by a word of caution or discipline. But safety authorities recognize that an aversion to goggles may be a sign of something else wrong.

If the goggles do not fit and are uncomfortable, this fault can be easily corrected. If, however, the man actually cannot see on the job, it may be time for refitting the eyes with prescription glasses adapted to the work he is doing. Lenses suitable for reading a chart, for example, might not be satisfactory if the man is transferred to the operation of a crane. It should be borne in mind, too, say the authorities, that eyes change and should, as oculists advise, be checked every two years, sometimes oftener.

"How foolhardy to expect results from a goggle program," remarked one authority, "if our employees, after years on the job, still have the same goggles they were given when first hired."

Discipline ranks high among means for enforcing goggle wearing to reduce the eye injury toll, but now the Wise Owl Club idea seems to have introduced something else. Backers of the plan point out that it is taking safety to the worker on a strictly personal, man-to-man basis. By making the gold pin a mark of distinction, the scheme is psychologically making men want to wear goggles, which is all to the good for everyone.

Perhaps the time is ripe to consider how this golden emblem which symbolizes the new day in eye protection can help solve your plant's problem of preventing the "living death" of blindness from striking someone working for you.

SCHEDULE OF MEETINGS OF CHEMICAL ENGINEERS INSTITUTE

Following is a list of future meetings which have been announced by the American Institute of Chemical Engineers: Regional meeting to be held in Rochester, New York, September 16 through 19, 1951; Annual meeting scheduled for Atlantic City, New Jersey, December 2 through 5, 1951; Regional meetings to be held at Atlanta, Georgia on March 16 through 19, at French Lick, Indiana on May 11 through 14, and at Chicago, Illinois on September 4 through 6, 1952; and the 1952 Annual meeting scheduled for Cleveland, Ohio on December 7 through 10, 1952.

CAMBRIDGE WIRE CLOTH EXPANDS FACILITIES

The Cambridge Wire Cloth Company has announced the expansion of the facilities of its Metal Specialties Division. Sales activities will now be under the direction of Wallace I. Pink, while Edson Leonard will head the newly created Engineering Department. Everett Creighton remains in charge of the production facilities serving the Metal Specialties Division.

• An award for outstanding industrial advertising has been given to Libbey-Owens-Ford Glass Company by the National Industrial Advertisers Association.

EAST ASIATIC GLASS

By DOROTHY BLAIR

PART I—CHINA

Interest in the subject of glassmaking in eastern Asia is at once absorbing and baffling: absorbing because of the nature and quality of the ancient glass found in this area and because of the many unsolved and provocative problems it presents; baffling because investigations in this field are so comparatively recent that, although valuable pioneer work has been done by some of our overseas colleagues, only a few paths have been broken out as yet and the guideposts are proportionately few.

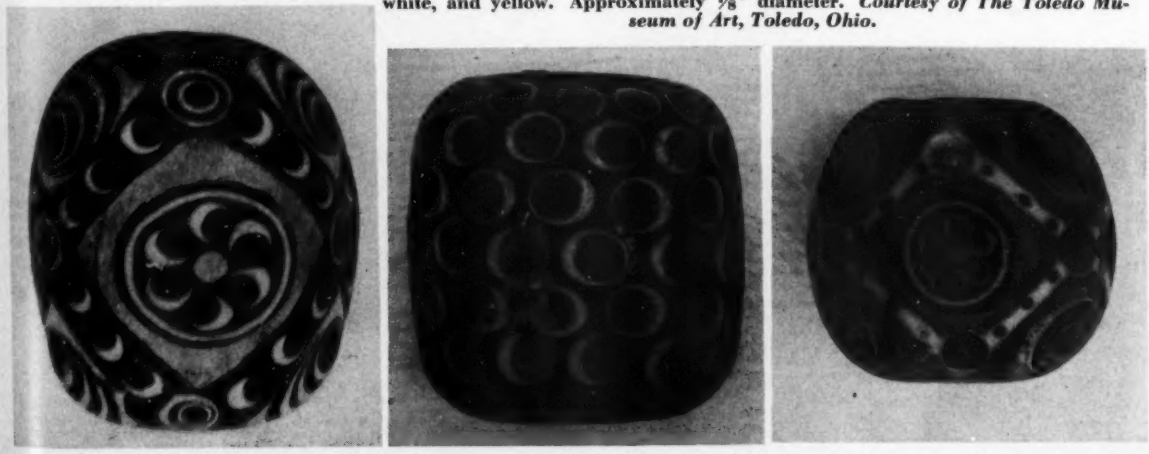
One of the fascinating aspects concerns the origin of glassmaking in the east Asiatic countries. In China, was the discovery an off-shoot of the traditional early alchemists' search for the elixir of life? Or, was the secret of glass first introduced from the west by peoples of very early times advancing across the steppes of Central Asia? Was it first brought by sea to southern China by daring seafarers from India and beyond? Or, was it an indigenous affair, originating independently in early China?

Certainly foreign influences played important roles, especially in later times. But artisans in China were masters of several intricate crafts as early as the closing century of the Shang Dynasty (1766-1122 B.C.). They produced superb cast bronzes, sometimes with inlays of semi-precious stones and of lacquer. They created a delicately fine carved white pottery. More pertinent to our theme are pottery vessels of the same twelfth century B.C. with areas of thin glaze, now analyzed as "of a feldspathic nature"[1], suggesting at least a familiarity with some of the raw materials associated with glassmaking. At any rate, by the latter part of the Chou Dynasty (1122-221 B.C.) glass objects of masterly workmanship in the form of beads, small molded objects, and glass inlays in metal objects were interred in Chinese tombs. These are quite generally assigned to the interval from the fifth to the third centuries B.C., though some still believe them to be slightly later.

The beads are highly interesting. Some resemble types of approximately the same period in the west, but many show a more subtle designing and a superior surety of handling characteristic of early Chinese artistry and therefore seem to bespeak a Chinese origin (Figs. 1-2). Furthermore, many are heavy and analysis reveals lead, and usually barium, in appreciable quantities, as well as high specific gravities. In contrast, western beads, with rare exceptions, lack lead and barium and are of lower specific gravity. This seems to indicate that the beads of China were neither imported nor formed of imported glass metal, but were apparently created on Chinese soil from China's own resources. C. G. Seligman and H. S. Beck, in their scholarly report of investigations (see Bibliography), concluded that western beads were brought into China as early as the fifth century B.C. "in sufficient quantities to be admired and to be copied on a considerable scale", but with modifications.

An unusually handsome example is the large bead with inlays shown in Figure 1A. The body glass is a translucent rich dark blue, which, like most of the blue in this early glass, remains especially well preserved. The various "eye" motifs of the design are fashioned of stratified layers of dark blue and opaque white glass. Since the layers are fairly thin, the blue is often modified to a lighter tone by an underlying layer of white. An opaque yellow is often introduced in these beads in effective contrast to the blue and white. Frequently this is badly deteriorated and is sometimes of a curiously strident orange tone, not at all in keeping with the usual Chinese sense of harmony so that one wonders if it had originally been different. In the bead shown, the yellow is rather conspicuous as it was used for both the lozenge-shaped and triangular backgrounds of the more complex motifs.

The eye element is used in this bead in four different forms. The simplest is a circular form at the four corners of the yellow lozenges, made up of two layers of white and two of blue. Then there is a somewhat oblate form in which a blue "pupil" is encircled by white, wider



Figs. 1A, 1B, and 1C. Glass Beads of the 5th-3rd Centuries B.C. Dark blue, white, and yellow. Approximately ⅞" diameter. ***Courtesy of The Toledo Museum of Art, Toledo, Ohio.***

Figs. 2A and 2B. Glass Beads of the 5th-3rd Centuries B.C. (A) ⅞" over-all diameter. *Courtesy of The Toledo Museum of Art, Toledo, Ohio.* (B) 1⅛" over-all diameter. *Courtesy of the Royal Ontario Museum of Archaeology, Toronto, Canada.*

at one side. This is characteristic and in any unit group of such eyes the widening is always at the same side, imparting a realistic vitality. Here the eyes seem almost to be moving along the borders they form around the lozenges. Interspersed between these borders, at top and bottom of the bead, is the third form—an increasingly complex oblate eye of four blue and three white layers, superposed on a three-pointed ground of yellow. These layers bulge out ever so slightly. The fourth most complex form is the "revolving eye" motif centered in the yellow lozenges. Here six oblate eyes encircle and actually seem, by the vital occult proportions of their parts, to revolve around the central white disc. When such a design is as vibrant as this one it seems without question purely Chinese, for constant variation and flux are salient emphases in Chinese philosophy and when injected into design produce the peculiarly vital rhythms so often dominant in Chinese artistic expression. Certainly there is such vitality in this outstanding bead.

Another handsome bead (Fig. 1B) has a thin, black lacquer-like layer remaining as a background. Such a deliberate black covering has been seen in other beads and there are some in which such a layer is now gone, leaving the design "high and dry" in relief. In this bead, as in some others, there is a partial grayish film, slightly iridescent, over the blue of the "eyes".

The beads of Figures 1C and 2 represent other manipulations of the eye design. Those of Figure 2 have high nodules stratified in layers of blue and white, with one orange layer in each nodule. This form is also known in the west, but these two from China are particularly elegant. Note that in each the upper and lower horizontal rows of nodules are slanted obliquely in opposite directions, again a typically Chinese touch, breaking away from static monotony. The Toronto bead (Fig. 2B) has three more nodules around the center of the bead which do not slant. In the Toledo bead (Fig. 2A), instead of center nodules there are three compound-eye motifs. There are also small and erect, interspersed nodules. In Figure 2A the uppermost layers of these are now lost, exposing the concavity of the underlying surface.

The body glass in all of these beads except Figure 1C is the typical translucent dark blue, but that of Figure 1C is pale green with inlays chiefly of blue, white, and yellow with some touches of green.

Other types of glass from, or purporting to come from, sites of this period include: beads of various styles; inlays of "eyes" or complex eye motifs in objects of bronze and silver; stratified eye motifs seemingly "painted" in glass on vessels of glass or pottery, and on some beads of frit or faience; some ornaments for appliqué; and objects for ceremonial use. Some of these are perplexing indeed and much investigation is needed for clarification in dating. There is, of course, no blown glass, but fragments exist of vessels evidently formed over a core.

During the Han Dynasty (206 B.C.—221 A.D.) glassmaking continued, but here also we are on uncertain ground, except when stylistic aspects point dominantly to a Han date, or excavations are authentically documented. Eye motifs of glass are inlaid in some bronzes of the Han style, but in these instances the glass plays only a minor role and I think rarely if ever do these insets show the fine quality of earlier examples. Other Han items (as well as some attributed to the Chou Dynasty) are clearly imitations of jade forms. Many are so thoroughly corroded that study of the glass is dif-

Fig. 3. Glass Bead of the Han Dynasty used as an ear ornament. Translucent deep blue. 1 1/16" long. *Courtesy of The Toledo Museum of Art, Toledo, Ohio.*

ficult or impossible. It is often, however, cloudy, or slightly translucent glass, sometimes of a bluish or greenish tinge.

One well documented type of Han glass is an ear ornament which has been found in China itself and in widely separated areas of colonization in the far-flung Han Empire, such as Korea, South Manchuria, Central Asia, and Indo-China. In English these are variably called "capstan" or "drum" or "carinated tumbler" beads because of their form. They are most commonly of deep blue or greyed blue transparent or translucent glass, with tubular shaft, sometimes short and stubby but more often slenderized, with one end flaring rather widely, and with a narrow bore (Fig. 3). This type is well preserved, but there are others which were perhaps lighter in tone. They are now badly pitted all over and brilliantly iridescent. Whether the difference is due entirely to varying conditions of burial, or to differing date, or to differing localities of production, we cannot say at this time. Excavations of tombs at the Han site of Lo-Lang in Korea proved the purpose and use of these beads as ear ornaments, probably inserted in pierced ear lobes with the flaring end forward. They are carefully made. The rims of the flared end, which is concave, ordinarily show a precise, narrow bevel.[2]

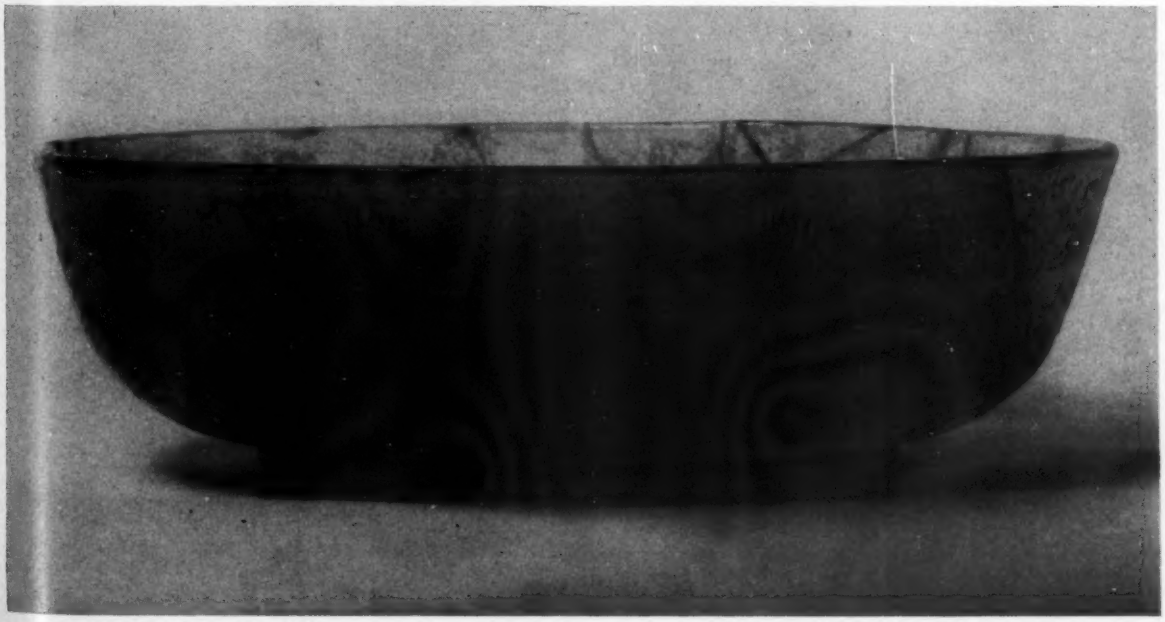
Few glass articles extant today can be assigned surely to the unsettled centuries between the Han Dynasty and the T'ang Dynasty (618-906 A.D.), an interval often called the Six Dynasties Period. Part of a small Buddhistic figurine of molded glass owned by Langdon Warner of Harvard University[3] is assigned to this period on stylistic grounds. It could have originated in China or in some region to the west. Official archives of the various Chinese kingdoms of the period refer to glass, but there is some confusion regarding the term used, which carries various connotations, such as both "glass" and "crystal". That glass itself was sometimes intended seems obvious from a poem by P'an Ni, an ode to an

Fig. 4. Head from a Glass Hairpin of the T'ang Dynasty. Transparent green. 3 11/32" long. ***Courtesy of the Gemeente Museum, The Hague, Holland.***

imported glass bowl, which expresses the marvel of its having survived the journey across hazardous deserts and the precipitous heights of the Pamir Mountains. In regard to other references, some authors have thought that ceramic glaze, rather than glass, was intended. One reference cites glass sent by sea from western Asia to a southern Chinese ruler, followed later by an artisan who could "turn stone into crystal" (i.e., glass?). Somewhat later, glassmakers from Central Asia arrived in north China, where they were reported to have found all needed materials. These artisans, it was said, even surpassed in color and brilliance the glass of the west. From the tone of the records it is clear that glass was now received in China as something new, which *blown* glass indeed was. A number of vessels unearthed in China seem to be importations of the late Six Dynasties, or slightly later, in that they exhibit throughout the characteristics of western glass. Or, they may have been made locally by craftsmen from the west.

In considering glass in China during the first millenium of our era, it is essential to consider the old cultural centers in Central Asia along the famous silk route to

Fig. 5. Glass Bowl attributed to the Sung Dynasty. Transparent colorless, now whitish, 2¾" high. ***Courtesy of The Toledo Museum of Art, Toledo, Ohio.***



the west. There much fragmentary glass has come to light. A few examples of Han ear ornaments have been found, and certain small beads are not unlike many found in China, Korea, and Japan. Beads, a few rare vessels, and many fragments of vessels from western Asia and Egypt have been uncovered, including blown glass, molded glass, glass with ground facets, glass with applied threads and medallions, gilded beads, and other types. There is slight evidence of some manufacture of glass in Central Asia, but very slight, and most seems to have come in with the caravans traveling along the silk route.

For the brilliant golden age of the Chinese T'ang Dynasty (618-906 A.D.), there are small glass ornaments which seem unquestionably not only of Chinese origin but of this period. There are molded hairpins of glass whose enlarged, flattened heads show designs of butterflies, clouds, and flowers (Fig. 4). Some ornate metal hairpins have glass insets. Glass bracelets take the shape of a coiled body with two dragon heads *en face* and the sacred jewel between. There are pendants, buttons, and small ornaments, many very light in weight and delicately colored.

Glass vessels exist which have come from China and are assigned to the T'ang Dynasty; and in a wonderfully preserved imperial collection in Japan, that of the Shosoin (to be discussed in a later paper on glass in Japan), there are vessels which may be of Chinese make of the time. But all of these present sundry problems. In fact, we have now arrived, in this summary, at an interval of about a thousand years of great uncertainty and confusion, covering not only the T'ang but the Sung (960-1280), the Yuan (1280-1368), and the Ming (1368-1644) Dynasties. As one example, we may observe the colorless bowl of Figure 5, owned by The Toledo Museum of Art. It is assigned, albeit tentatively, to the Sung Dynasty, whereas a blue bowl identical in shape, size, and ornamentation, owned by The Metropolitan Museum of Art in New York, is assigned to T'ang.

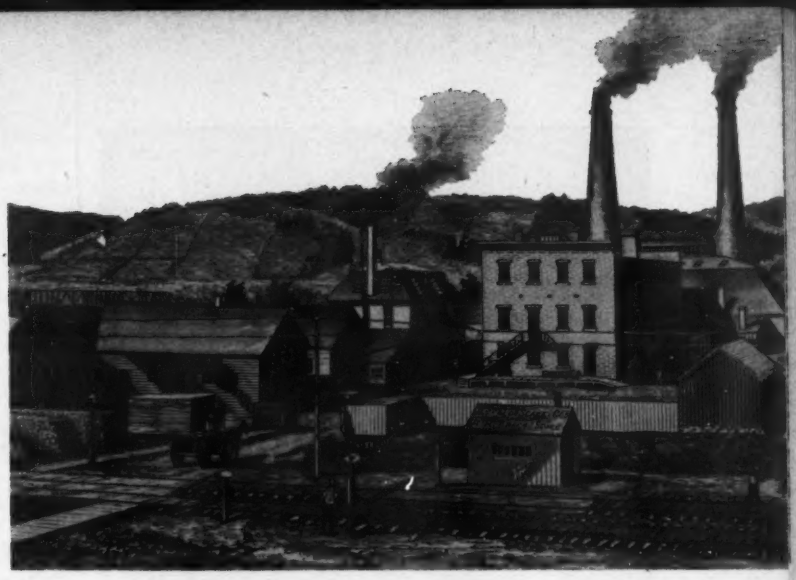
William B. Honey of the Victoria and Albert Museum in London has devoted much study to the problem of assigning dates, but his conclusions are not invariably accepted by other scholars. He assigns to the earlier years of the Ch'ing Dynasty (1644-1912 A.D.) some types of glass in European museums formerly attributed to earlier eras, and does so with much valid reasoning. But further study of many other individual examples

(*Continued on page* 368)

Fig. 6. Glass Bottle of the Ch'ing Dynasty; mark of the Ch'ien-lung Era (1736-1796). Semi-transparent deep blue. 9½" high. *Courtesy of The Toledo Museum of Art, Toledo, Ohio.*

Fig. 7. Glass Vase of the Ch'ing Dynasty. Red overlay on semi-transparent colorless ground flecked with opaque white. 7" high. *Courtesy of The Toledo Museum of Art, Toledo, Ohio.*

ONE HUNDRED YEARS OF PROGRESS FOR CORNING GLASS WORKS



Corning Glass Works' march of progress during the century 1851 to 1951, which was marked by considerable expansion in manufacturing facilities, is perhaps most notable for developments in research and technology that have made the most versatile industrial material in the world. The company's slogan, "Corning Means Research in Glass", means simply that Corning regards the material essentially as an engineering substance with virtually unlimited forms and uses waiting to be uncovered through experimentation and research.

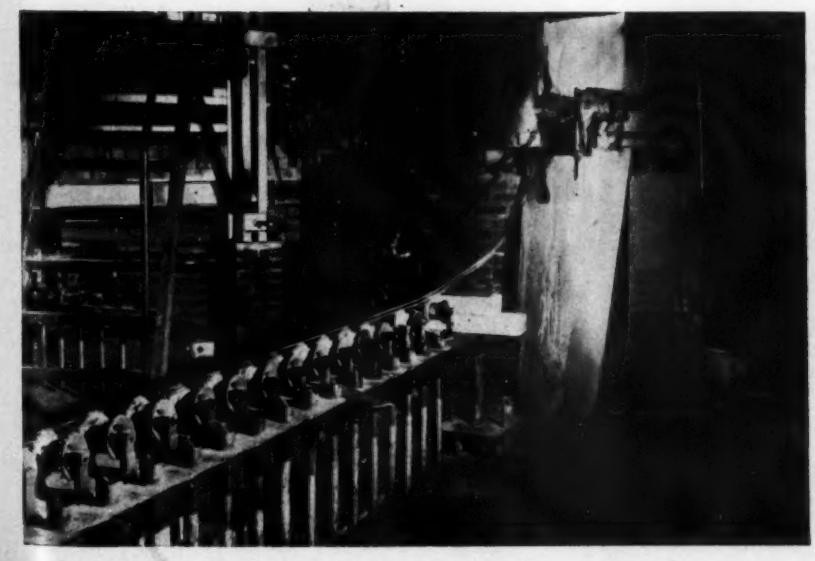
The physical result of this attitude has been remarkable, Corning having grown from a modest beginning until at present it operates 14 plants in six states and Canada and employs some 13,000 persons. Corning's progress, however, is more effectively highlighted by the series of new glasses and glass forms which have brought thousands of new products into everyday use.

The company's early history can be divided into three parts according to its different locales—Massachusetts, Brooklyn, N. Y., and Corning. Back in 1851, an English glass expert with the picturesque name of Gaffer Teasdale interested young Amory Houghton, Sr., owner of a profitable wharf business in East Cambridge, in the great possibilities of a glass manufacturing company.

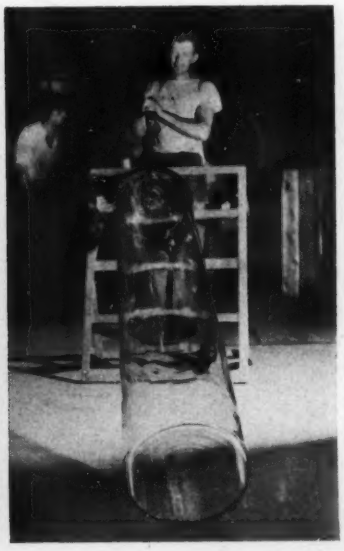
Houghton had the initiative to make quick decisions—he had been a successful contractor at the age of 23. In this case his decision to sell the wharf business and establish the Union Glass Company at Somerville, Massachusetts, was to drastically affect the lives of thousands of people and the development of modern industry in general. For 13 years Houghton operated a highly successful concern specializing in the manufacture of fine cut glass items. During the latter part of this period, Houghton's son, Amory, Jr., was associated with him and could be said to have laid the foundation for Corning Glass Works' leadership in glass research. Amory Jr., engaged in experiments on the composition and manufacture of fine glass which was to prove of great value in later years.

In 1864, Mr. Houghton sold the Union Glass Com-

Horizontal drawing. Molten glass follows onto a hollow revolving sleeve. A continuous tube is pulled off the mandrel and is automatically cut to desired lengths at the end of the draw.



The largest handblown item still produced at Corning Glass Works: a blueprint cylinder.



An early 20th century Corning handbulb shop. Now replaced by modern automatic machines capable of producing 1,000,000 bulbs per day, these shops were capable of a rate of better than 600 bulbs daily. At the right is Frank Hultzman, member of the shop which blew the first successful envelope for Edison's incandescent lamp in 1879.

pany and bought out the Brooklyn Flint Glass Company for reasons not disclosed in available sources but probably due to anticipated advantages of a metropolitan area. Thus was set in motion the chain of events which was shortly to bring big industry to a small upstate town, Corning, New York.

In 1868, Amory Houghton cast about for a more propitious manufacturing location. With a canny eye to advantages in the proximity of vital raw materials and fuel resources plus transportation facilities, he chose Corning. While still in Brooklyn he organized the Corning Flint Glass Company and began the removal of equipment to the new plant site.

CGW products in this early phase of the company's history comprised fine cut and blown tableware, both flint and colored, cane, thermometer tubing, lenses, and lantern globes. Gradually, however, the company gave

Formerly the standard method of making tubing, this ancient process is now used for just special jobs not adaptable to automatic methods.

up manufacture of tableware to concentrate on more practical commercial production and in 1872, cutting blanks were replaced by railroad signal ware and laboratory supplies. Corning's flexibility in regard to adapting its facilities to the development and manufacture of new products became increasingly apparent in the middle and late seventies.

In 1877, Charles Houghton, with the help of Dr. G. S. Mocler, a physicist from Cornell University, greatly improved the optical quality of lenses by patenting the inside flat corrugated lens. This marked the initial call upon scientific research for help in solving glass problems. Corning Glass Works was to rely more and more on the laboratory in achieving its future growth.

The incident which logically terminates the early phase of the company's growth concerns the oft-told story of the fabrication of the first bulb blank for Thomas Edison's new incandescent lamp. Charles Houghton had heard that Edison needed a lead glass envelope to make his lamp a practical reality. Following a visit by Houghton to Menlo Park, during which he convinced the inventor that CGW's long experience with this type of glass rendered it the logical agency to supply the envelope, a representative visited Corning and contracted for the manufacture of a number of bulb blanks. It was then in 1879 that Corning Glass Works first achieved national recognition through the work done by the hand shop assigned to the fabrication of the blanks.

Corning's growth as an important glass manufacturer as well as innovator already stepped up by the Edison incident, received a further boost when, in 1899, Alanson B. Houghton, started Corning Glass Works on the road to the development of signal glasses to replace the hopelessly inadequate signal ware then in use. Charles Houghton's contribution of interior corrugations on signal lenses in 1877 was a substantial contribution to the streamlining of railroad signal ware. What remained to be done was the standardization of signal values and color systems, the most difficult job of all.

At that time each road had its own signal system and no two railroads used the same color standards. As a result the incidence of railway mishaps was enormous. Alanson engaged Professor E. W. Scripture of Yale University to undertake a laboratory investigation for the purpose of establishing correct values for each of the possible signal colors. In 1904, preliminary research having been completed, Dr. William Churchill, an assistant to Scripture, established an optical laboratory for the specific study of signal lenses and colors.

At the start of Dr. Churchill's experimentation, red colors in service were distinctly yellowish or orange, greens were of varied hue, and yellow was still in the experimental stage. He proceeded to subject all available glasses to rigid tests, measure intensities of light and color transmission both in the laboratory and the field. His object was to get one definite shade in each of the colors.

In 1905, Dr. Churchill, at a meeting of the Railway Signal Association, revealed what Corning Glass Works had done: they had developed a constant red; a green of slightly bluish tint; and a yellow lying midway between the red and green hue.

For three years these constant colors, the hope of railroad men the country over, were given thorough

trials under every conceivable condition and before hundreds of critical but hopeful visitors to Corning. In 1908, the Association adopted a standard specification embodying the new colors exactly as CGW had developed them and for the first time railroads had standardized signal lights.

Later, CGW also developed higher transmission lenses and colors so that these "eyes for safety" could be visible at a greater distance without sacrificing the vital color purity. These new standards, adopted in 1918, form the basis of signal light systems throughout the United States and Canada and many other nations. Thus glass from Corning Glass Works furnaces became international in use.

Eight years later, the year of the death of Charles Houghton, apparatus for the vertical drawing of glass tubing was patented. The modern thermometer tubing tower at Main Plant still embodies the basic principles of that important development. Corning Glass Works' remarkable expansion during this period is reflected in the fact that its volume of business in 1902 was 10 times that of 1875. In 1908 the company may be said to have entered the modern phase of its history.

The only research laboratory in the glass industry was installed, and Corning developed the first of its line of heat-resisting glasses for manufacture of lantern globes. This was the precursor of Pyrex ware. It was also used at the time for battery jars and lamp chimneys.

Five years later, shortly after "C" Factory was constructed, a Corning researcher cut off the bottom of a heat resistant glass battery jar. He then gave it to his wife and asked her to bake something in it. He was convinced that food could be cooked in Corning Glass Works' new heat resistant glass better than in any other type of receptacle. His wife proved it to his colleagues by baking, without mishap, a splendid cake. CGW's most famous line of ware had thus got its start.

Immediately CGW set about improving this promising new development. In 1915, the first heat resistant ware was placed on the market simultaneously with the application for the now-famous Sullivan-Taylor patents which were granted in 1919. The trade name "Pyrex" was originated by the company in 1915 and since has become famous as a symbol of the finest in heat resisting glasses.

The year 1916 might be termed the beginning date of CGW's large scale production of this ware. That same year a lime composition glass was substituted for the lead glass in use up to that time. This glass was of the required softness to allow the use of automatic machines in the manufacture of bulb blanks and vastly increased production, with resultant reduced prices, were made possible.

The production and sale of chemical glassware was begun in 1917 under the trade name of Pyrex. Corning Glass Works has since become the nation's foremost producer of this type of ware. The period from 1917 to 1921 saw CGW making rapid forward strides in new development for railway signal ware and granting of various patents concerning signal lenses.

In 1921 Amory Houghton joined the company. Mr. Houghton subsequently served as President, 1930-1941, and has been Chairman of the CGW board since the latter year.

Another development, this time in relation to the machines which turn out the bulbs, was to shortly again step up their production. William Woods, a CGW employee and longtime handler of the primitive "automatic" machines in use in the late teens, had for some time realized that they were merely "imitating" the movements of the hand-blower on a faster scale. Out of this realization, in 1922, was born the idea for the famed Corning Ribbon Machine. Woods' outline showed that a machine using the principle of dropping a gob of glass down through a hole with the aid of a puff of air could, by eliminating the need of a gatherer, handle a continuous flow of glass.

David E. Gray, who had entered the company's employ in 1916, was paired with Woods in the translation of the latter's idea into an actual machine. Installed at Main Plant in the early 20's, it proved spectacularly successful. Thus the ingenuity of CGW personnel again helped to bring an essential commodity—the electric light—within the reach of everyone.

The year 1922 is significant in CGW history due to

Chronological Highlights in the Expansion of Corning Glass Works

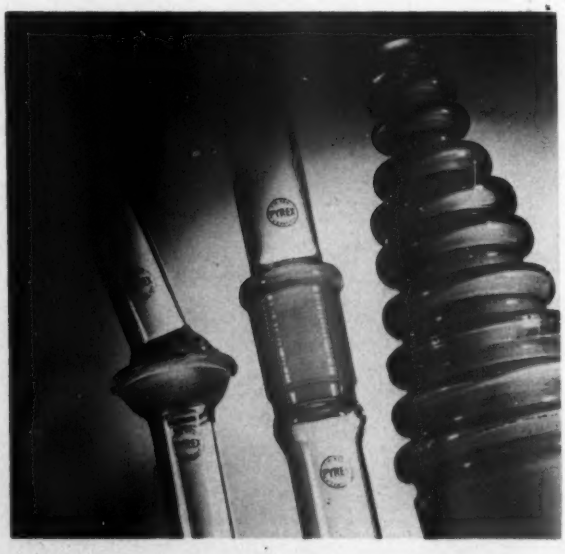
1851—Organization founded as Union Glass Company in Somerville, Massachusetts.
1864—Moved to Brooklyn, N. Y. as Brooklyn Flint Glass Works.
1868—Moved to Corning, N. Y. as Corning Flint Glass Company.
1875—Incorporated as Corning Glass Works.
1879—First glass bulb for Edison's incandescent lamp.
1897—First machine for drawing thermometer tubing.
1904—"B" Factory built.
1907—Standard colored glasses for railroad signal lenses.
1909—Heat-resistant glass for railroad brakeman's lanterns.
1915—Pyrex brand heat-resistant glass cooking ware.
1916—Glass for X-ray shields.
1916—Wellsboro, Pennsylvania, Plant built.
1917—Pyrex brand laboratory and pharmaceutical glassware.
1924—Central Falls, R. I., Plant acquired.
1924—Corning Fiber Box Company organized.
1925—Blue Ridge Glass Corporation organized, Kingsport, Tenn.
1925—Corhart Refractories Company, Inc.
1926—Development of Corning "ribbon" machine for automatic production of low-cost bulbs for incandescent lamps.
1930—Pot and Clay Plant acquired.
1930—Fall Brook Plant completed.
1932—First ribbed telescope mirror blank cast.
1934—Successful casting of 200-inch disk for Mt. Palomar telescope, the largest single piece of glass ever cast.
1935—Fiber Products Plant built.
1935—Manufacture of glass fibers.
1936—CGW consolidates with Macbeth-Evans Glass Company; Charleroi, Pennsylvania, Plant acquired.
1936—Pyrex brand top-of-stove ware.
1938—Pressware Plant completed in Corning.
1938—Owens-Corning Fiberglas Corporation organized.
1939—Automatic production of glass Christmas tree ornaments.
1939—Vycor brand 96% silica glass (super heat-resistant) announced.
1940—Double-Tough tumblers.
1942—Old Steuben building converted into Vycor Plant.
1942 to 1945—Corning devotes 75% of its facilities to war production and successfully completes 174 separate research projects vital to the war effort. Wins 14 Army-Navy "E" Awards.
1942—Minority interest in Cristalerias Rigolleau, Argentina, acquired.
1943—Dow Corning Corporation organized.
1944—Corning develops automatic manufacture of optical glass.
1944—Minority interest in Vidraria Santa Marina, Brazil, acquired.
1944—Bradford, Pennsylvania, Plant acquired.
1945—Leaside, Ontario, Plant acquired. CGW of Canada, Ltd., formed.
1945—Minority interest in Cristalerias de Chile acquired.
1945—Germicidal lamp glass.
1946—Parkersburg, W. Va. Plant completed.
1947—Photosensitive glass for three-dimensional permanent pictures in glass.
1947—First automatic production of television bulbs.
1948—Muskogee, Oklahoma, Plant completed.
1948 to 1950—Corning makes major contributions to the nation's expanding television industry with automatic production of television picture bulbs.
1950—Pilot Plant No. 2 and Engineering building constructed in Corning.
1950—Electrically-conducting glass announced.
1950—Albion, Michigan, Plant completed.
1951—Minority interest in Cristales Mexicanos, Mexico, acquired.
1951—Corning builds new plant in Danville, Kentucky, for the manufacture of glass bulbs and tubing.

the arrival of S. L. Lebby with a patented combination of a lensmirror which later served to increase efficiency of color light signals. The production of CGW's first telescope mirror blank at this time foreshadowed the company's tremendous accomplishments years later in the production of the Mt. Palomar 200-inch mirror. It was also in that year that the company formed one of its first foreign affiliates, Societe LePyrex of France. The following year, CGW established its first health insurance for employees and set up a company hospital and clinic staffed by a physician, dentist, nurses, and having complete medical equipment.

The next seven years were a period of rapid expansion in plant facilities both in and out of Corning. In 1924, the Central Falls Plant in Rhode Island was acquired, while in Corning Pyrex brand nursing bottles began rolling off production lines. During that year also, the Corning Fiber Box Company was organized as a CGW subsidiary to provide shipping materials for the company's products. In 1926 the first shipment of bulbs turned out by the ribbon machine was delivered to a CGW customer. The organization of The Corhart Refractories, a subsidiary of CGW, took place in 1927. This concern, whose plant is located in Louisville, Ky., manufactured electro-refractories developed by CGW's research laboratory.

Another move into foreign fields was made by the company when the French affiliate, Societe L'Electro Refractaire, was established at Paris in 1928. On September 13 of that year CGW held its initial employees' annual service dinner celebrating the establishment of the company in Corning.

Corning Glass Works constructed its first "outside" plant in Corning with the building of the Fall Brook Plant in 1930. This unit, a large scale producer of glass tubing, is located on the site of what was once the Fall Brook Railroad. The reason for its construction was the fact that tubing demands had far outstripped production at the company's Main Plant. Production was begun with the installation of two automatic machines and since has been increased as demand has stepped up.



Tough, interchangeable ball and socket joint that permits movement without breaking.

In 1931, Corning built the Pot and Clay Plant, adjacent to Main Plant, for the purpose of speeding up the company's supply of refractory materials. From this installation, clay products are shipped to all CGW plants. The Houghton Memorial Clubhouse on the corner of Walnut and Market was also completed that year, giving CGW employees access to many types of indoor recreation.

A project destined to focus the eyes of the world on Corning was begun in 1931 when representatives of the California Institute of Technology authorized Corning Glass Works to make a 200-inch disc to be utilized as the mirror for the proposed Mt. Palomar (Hale) Telescope, the world's largest. The disc was to utilize a ribbed structure and was to be made of one of Corning's borosilicate, heat resistant glasses. In 1934, following three years of experimentation and effort on the part of Corning personnel, the first 200-inch disc was poured. Unforeseen technical difficulties, however, resulted in an imperfect disc and plans were immediately laid for the casting of another. This was accomplished in December of the same year and in March of the following year began its journey to Pasadena for grinding.

In June 1948, after years of finishing operations, the Mt. Palomar telescope was dedicated and named after its founder, Dr. George Ellery Hale. During the remainder of Amory Houghton's presidency, the tempo of the company's growth increased. In 1933, Steuben Glass, Inc., was organized as a fully-owned subsidiary for the retail sale of Steuben decorative ware which was made in Corning. There is now a shop in New York City, as well as retail outlets in other large cities. The consolidation of Corning Glass with Macbeth-Evans Co. of Pittsburgh was consummated in 1936, the new CGW manufacturing unit being known as the Charleroi Plant. Next year the Pittsburgh Corning Corp. was formed jointly by the Pittsburgh Plate Glass Company and Corning on an equal financial basis. This corporation, whose plants are located at Port Alleghany, Pa. and Sedalia, Mo., manufactures hollow glass construction blocks and similar articles.

Meanwhile, CGW's local expansion in building facilities was proceeding apace. In 1937, the company announced the completion of the Pressware Plant below Fall Brook. This unit is a mass producer of Corning's consumer products, such as casseroles, custard cups, pie plates, and the like. That same year a new shipping building was constructed on Pine Street and the Personnel building, adjacent to Main Plant Office Building, was finished. The company also announced completion of the Corning Realty Corporation apartment houses on High Road in Corning for the use of CGW personnel. The New York Office Building was also built in 1937.

The Owens-Corning Fiberglas Corp. was similarly formed in 1938 with Owens-Illinois Glass Co. to manufacture fiber glass. The initial factory was at Newark, Ohio, and additional plants have been built at Ashton, R. I., and Huntington, Pa., and Kansas City, Kans. This affiliate took over manufacture of ware produced until that time by CGW's Fiber Products Plant in Corning.

In 1939 Corning invaded the Christmas tree ornament field when it applied the Corning Ribbon Machine

to mass production of that item. Hitherto dominated by the German "cottage trade" — handblowers — the ornament field had been greatly reduced when imports from Germany were cut off at the start of World War II. The ribbon machine's capacity for astounding production volume soon made the United States virtually independent of foreign imports.

For several years prior to 1939, Corning researchers had been seeking a suitable substitute for pure quartz, a glass that could withstand terrific temperature changes and thermal shock without shattering. In the course of research, Corning found that glasses of certain compositions behaved strangely under various heat treatments. It appeared that there were two distinct types of glasses contained in one shell in certain of these. Through a series of experiments, they further discovered that the unneeded type of the two glasses could be dissolved out leaving but a skeleton. Upon application of heat it began shrinking until it was two-thirds of the original size without losing its identity or suffering any change of shape. In this completed state, this 96% silica glass could be taken from a blazing-furnace and plunged into a vat of ice water with no change whatsoever.

Sold under the trade name, Vycor, these products have since found an increasing number of applications, such as calcining dishes and glass insulators for cyclotrons. In 1942 Corning organized a plant in Corning for manufacture of Vycor products.

Wartime demand for optical glass set Corning researchers on the track of a new and more streamlined method of making this quality substance. Hitherto optical glass had been produced solely by the laborious "pot transfer method". Corning, after years of effort, came up with a new continuous process in 1944, which while too late to have an important effect during World War II, has rendered this country relatively independent insofar as optical glass production is concerned.

There are special glasses, developed by Corning, 1945, which are capable of transmitting the very small ultraviolet waves which kill germs. These glasses have played an important part in the increasingly widescale use of germicidal lamps. These units are now routine in such places as hospital nurseries, operating rooms—for sterilization of instruments—and factories producing anti-biotics and similar life-saving drugs. Meat packing houses also employ germicidal lamps in many cases.

In 1947, the development of a new photographic medium, photosensitive glass, was announced by Corning. Originally considered principally as a means of obtaining three-dimensional portraits that, except for breakage, would last indefinitely without deterioration, photosensitive glass has already found several practical applications. Chief among these is Fota-lite in which the new glass has been used to form a revolutionary lighting technique. Ingrained throughout the length, width, and depth of a pane of Fota-lite is a criss-cross pattern of white lines. In a light fixture, Fota-lite acts to diffuse light rays by cut-off thus greatly reducing glare. Photosensitive glass is also being used for different decorative purposes in construction.

E-C glass, announced by Corning in 1950, consists of a good insulating chemically-resistant glass with an electrically conducting transparent coating fired to its surface. This film, though capable of conducting a current, is sufficiently resistant to the electricity to cause heat. Its initial use for heating panels provides uniform distribution of heat over the entire panel surface with controlled temperatures up to 660 degrees Fahrenheit.

Corning glass pipe is used to make everything from magnesium to tomato juice and wine. Special Pyrex brand glass is used for the piping combining visibility with mechanical strength and high resistance to chemical attack.

A major achievement of Corning Glass Works during the past decade has been its work in the development of large-scale production of television bulbs. In 1947 it gave the television industry vastly increased production of picture bulbs through development of automatic manufacture of this basic TV component. During 1948 through 1950 further streamlining of production methods and a number of technical improvements in the bulbs themselves were announced. At present Corning is producing parts for the television industry in several plants.

World War II and post-war developments found little, if any, slackening in the company's tendency toward expansion and exploration of new forms of glass. During the war more than 75 per cent of the company's production were war items, including Army-Navy messware, radar and proximity fuse bulbs, optical glass for bombsights, navigating devices, periscopes, field glasses, range finders, fire-control equipment, laboratory and medical glassware, and instrumental panel and navigation lights for aircraft and marine vessels. In addition, a wide variety of precision-finished products were made. Corning worked on 174 research and development projects for the three branches of the service and was awarded 14 Army-Navy "E"s.

In 1942 Corning designed and built an optical glass plant in Parkersburg, W. Va., for the government. In 1944 it leased part of this plant for the manufacture of chemical and apparatus ware, and in 1946 purchased it outright and installed glass tube drawing facilities.

The organization of the Dow-Corning Corporation with Dow Chemical Company for commercial production, primarily for war purposes, of the resistant organosilicon compounds known as silicones originally developed in Corning. In 1943 Corning took its first step in developing wider South American markets by acquiring a minority interest in the leading glass manu-

(*Continued on page* 377)

RECENT TRANSLATIONS OF RUSSIAN PAPERS OF INTEREST TO THE GLASS INDUSTRY

Abstracts of four papers which appeared in the Russian journal of the glass and ceramic industries.

PURIFICATION OF SAND FOR GLASSMAKING

According to I. B. Shlain, V. A. Meitina, Ya. V. Timoshkov, and R. Ya. Moness, *Steklo i Keramika* (Glass and Ceramics) *7*, No. 10, p. 5 (1950), the sands used in glassmaking in Russia can be classified as to their principal impurities in the following manner:

A. Film contamination: 1. Clay and feldspar
2. Glauconite
3. Others

B. Grain contamination: 1. Clay and feldspar
2. No feldspar

Class A contains sands in which many quartz grains are coated with an hydroxide film containing iron, and the amount of iron present in these films is 10% or more of the total iron content of the sand. Group A1 includes sands in which over 40% of the total iron is bound with clay, while in group A3 clay contains less than 40% of the total iron.

Class B embraces sands in which less than 10% of the total iron is present in the films coating some quartz grains. Again, the difference between the two groups is based on the fraction of the total iron present in the clay fraction (over 40% in B1, less than 40% in B2).

The methods used for sand cleaning differ somewhat for the different groups. The treatment of group A1 includes (1) wet crushing and removal of the clay fraction, (2) screening, (3) flotation, (4) grinding and destruction of the film, (5) silt removal, and (6) drying. The treatment of group A2: (1) wet crushing (no removal of clay), (2) screening, (3) grinding and destruction of the film, (4) silt removal, (5) flotation, and (6) drying. For group A3: (1) wet crushing, (2) screening, (3) flotation, (4) grinding and destruction of the film, (5) silt removal, and (6) drying. For group B1: (1) wet crushing and removal of the clay fraction, (2) flotation, and (3) drying. For group B2: (1) wet crushing, (2) screening, (3) flotation, (4) silt removal, and (5) drying.

The machinery used in these operations is briefly described in the original paper.

The procedure was tested by two glass works. The Experimental Glass Works reduced the percentage of Fe_2O_3 from 0.03-0.15% to 0.02-0.04%. The Autoglass Works lowered it from 0.04-0.07% to 0.035-0.04%.

HALF-HARDENED GLASS

S. G. Lioznyanskaya and G. M. Bartenev in *Steklo i Keramika* (Glass and Ceramics), vol. *7*, No. 8, p. 5 (1950), point out that "half-hardened" glass for some applications is better suitable than either annealed or fully hardened material. Glass is "half-hardened" when it is cooled more rapidly than in an annealing oven, but less rapidly than by a blast of air. It has greater mechanical strength and greater thermal endurance than annealed glass, but when finally broken, it does not form small fragments as hardened material does but rather gives cracks similarly to annealed specimens. This last mentioned property is advantageous in aircraft windows which remain transparent also after being cracked, in miners' lamps as even cracked glass prevents their flame coming in contact with the atmosphere, and so on.

The simplest procedure of "half-hardening" is to allow the hot sheet to cool in air in the conditions of natural convection. The birefringence, expressed as the path difference ($m\mu$/cm. or 10^{-7} cm/cm.) achieved in a plate 5.91 mm. thick, was e.g., 250 after cooling from any temperature between 582°C. and 689°C. However, the duration of heating required to achieve this birefringence depended on temperature; it was 7 minutes at 582° and only 3.5 min. at 689°C. Heating above 670°C. is not advisable to avoid the plate being deformed. These values are for a glass containing SiO_2 71.3, Al_2O_3 0.7, Fe_2O_3 0.1, CaO 7.6, MgO 3.3., Na_2O 15.9, SO_3 0.7%. When 16.5 mm. thick plates of the same glass were allowed to cool in air, the birefringence was 650. Minimum time of heating was 15 min. at 582°C., 8 min. at 689°C.

The improvement produced by such a cooling was tested in several ways. In all instances, "half-hardened" specimens were compared with similar plates, also first "half-hardened" but then subjected to annealing. The "half-hardened" specimens were not compared with "raw" specimens because the additional heating included in the "half-hardening" process may cause disappearance of surface cracks and, consequently, increase in strength which would be independent of the manner of subsequent cooling.

Plates of 120x30x5.8 mm. were "half-hardened" to birefringence of 246. Then they were heated to various temperatures and rapidly immersed in water of 14.5-15°. The hottest plates which did not crack during this operation had the temperature of 146°. The corresponding temperature for annealed plates was 85°. The minimum bending stress which caused rupture of "half-hardened" plates was 1072 kg.weight/sq.cm. The corresponding figure for annealed plates was 634.

Plates of the two kinds were compared also in two standard tests for the glass intended for miners' lamps. All 100% of the "half-hardened" plates passed these tests. In the test consisting in heating from 15°C. to 100°C. and cooling back to 15°C. (the conditions not further described), 71% of the annealed specimens failed; 65% of the annealed plates failed in the lamp. (No description of the test is given.)

Bartenev's theory predicts a definite relation between the maximum temperature difference (ΔT) which a glass can endure and the following mechanical constants of the glass: the coefficient of linear expansion (β), the modulus of elasticity (E), Poisson's ratio (σ), and the ultimate tensile strength (P). This relation is

$$\Delta T = \frac{P(1-\sigma)}{\beta E} \qquad (1)$$

when the whole plate is cooled,

$$\Delta T = \frac{3P(1-\sigma)}{2\beta E} \qquad (2)$$

when only one point of the hot glass plate is cooled, and

$$\Delta T = \frac{3P(1-\sigma)}{\beta E} \qquad (3)$$

when one point of a cold plate is heated.

The glass used had $\beta = 86 \times 10^{-7}$ (degree centigrade)$^{-1}$, $E = 6.75 \times 10^5$ kg.weight/sq.cm., $\sigma = 0.22$, and consequently $\frac{\beta E}{1-\sigma} = 7.45$ kg.weight/sq.cm. x degree C. Hence, equation (1) predicts ΔT to be $\frac{1072}{7.45}$ degrees C. for "half-hardened" plates, see above. This ratio is 144°, i.e., considerably greater than the experimental value (146-15) = 131°C. For the annealed plates the calculated ΔT is $\frac{634}{7.45} = 85$°C., again greater than the experimental value (85-15) = 70°C. This discrepancy probably is due to the use of bending stress in the calculations while P in equation (1) means strictly the maximum tensile stress. Breaking stress for bending is greater than the breaking stress for pulling because the area under maximum stress is much smaller in the instance of bending.

RELATIVE DATA ON THE GLASS INDUSTRY IN U.S.S.R.

According to *Steklo i Keramika* (Glass and Ceramics) 1950, No. 11, and 1951, No. 1, the production of window glass in 1948 was 123%, in 1949 152%, and in 1950 "almost double" the output in 1940 (the last pre-war year). The percentage of high-quality glass was 45% of the total in 1940 and 67% of the total in 1950.

The yield of marketable goods from 100 units of glass mass was 67 units in 1940 and 72 units in 1950. The yield of glass mass for 1 square foot of furnace in 1950 was 34% greater than in 1940, the number of working days of an average furnace per year increased by 17%, and the time lost on repair of furnaces decreased by 52%. No absolute values are given.

COMPARISON OF MULLITE AND QUARTZ BLOCKS IN TANKS USED FOR HIGH MELTING GLASS

Borosilicate glasses containing 10-15% B_2O_3 are made at 1550-1600°C. (2822-2912°F.) and fined at 1600-1650°C. (2912-3002°F.). Obviously, the attack on the refractories is marked at these elevated temperatures. M. D. Tamarin and A. G. Minakov communicated the results of their tests on two types of refractories in *Steklo i Keramika* (Glass and Ceramics) *8*, 10 (1951).

The exact composition of the batch used and the dimensions of the tank are not given. It is stated, however, that the tank depth was 60 cm. (23.7 inches).

When the *mullite* blocks were used, the resulting glass contained more Al_2O_3 and Fe_2O_3 the longer the tank worked. Thus, when the batch contained 1.4-1.8% Al_2O_3, the glass had sesquioxide percentages as in Table I.

TABLE I

	Al_2O_3	Fe_2O_3
On the 10th day of operation	1.55	0.11
20th	2.05	0.19
30th	2.99	0.21
45th	3.22	0.20
90th	3.34	0.26

One ton of glass dissolves up to 15 kg. mullite during its passage through the tank. As mullite contains 65-70% Al_2O_3, about 1% Al_2O_3 is thus added to the composition of glass. At the same time the Fe_2O_3 content increases.

In tanks used for manufacturing window glass, mullite blocks are attacked chiefly along the joints and at the level of the glass melt. However, high melting glass corroded mullite almost uniformly along the whole surface.

Along with the increase of the Al_2O_3 content, the frequency of stones and striae in the finished product also increased. Because of the incorporation of Fe_2O_3 the transparency of the glass decreased. For 1 cm. thickness the transparency was 86.6% at the start of the operation, 80.8% thirty days later, and 70-73% 110 days later.

This deterioration of glass took place although more time was given for melting and fining the longer the tank was used. Thus, on the

10th 30th 60th 90th and 110th day of operation
24.8 25.3 28.4 31.0 and 36.0 hours

were needed for converting batch into glass. The percentage of glassware rejected increased from 5% on the 10th day to 23% on the 110th day.

In another operation, the tank was allowed to cool after 45 days' work. The glass mass remaining in the tank was composed of three distinct layers. The bottom layer was 10-15 mm. thick and crystalline. Above it, a dark layer 40-50 mm. thick was situated. This was surmounted by glass appearing normal. Table II shows the composition and the specific gravity of the three layers. When the tank was allowed to cool after an operation of 5 months, the thickness of the dark layer was as great as 250 mm.

TABLE II

	SiO_2	Al_2O_3	Fe_2O_3	Specific gravity
Upper layer (normal)	78.64	2.93	0.12	2.38
Middle layer (dark)	69.48	13.63	0.29	2.44
Bottom layer (crystals)	62.36	25.74	0.22	2.57

When blocks of *fused quartz* were used, the results were quite different.

The depth of destruction of quartz was 2-3 mm. after 50 days of operation, 5-10 mm. after 100 days, and 30-40 mm. after 200 days. This destruction results in the transfer of 1.5-2 kg. of silica into every ton of glass mass, i.e., in the increase of the silica content of the glass by 0.15-0.2%. This variation is so small that the sesquioxide content of the glass almost does not change during an operation, as can be seen from Table III.

Equally stable is the duration of melting and fining.

(*Continued on page* 369)

PARIS MEETING OF INTERNATIONAL COMMISSION FOR GLASS

The International Commission for Glass, made up of representatives of glass technical societies of nine countries, held its 1951 meeting at the Societe Prover, Paris, June 5 to 9. The Executive Committee of the Commission met on the first day to develop agenda and proposals to be acted upon by the business session of the full Commission on the last day.

Two full days were devoted to symposia, with papers on physical and chemical testing of glass, control of quality, and temperature measurement. On Friday, visits were made to the splendid research laboratories of St. Gobain, now partly complete, to the optical glass plant of Pasa-Mantois, and to the palace at Versailles.

Emeritus Professor W. E. S. Turner presided, and the Honorary Secretary is Dr. B. P. Dudding. Other members of the Executive Committee in attendance were Dr. Bernard Long, Vice President; Dr. W. M. Hampton, Treasurer; Dr.-Ing. R. Allolio, Dr. S. R. Scholes (representing H. R. Lillie), Dr. J. M. Stevels, and Mons. H. Vandecappelle, members.

Other members of the Commission who came to the meeting were Mons. Henri, of the Union Scientifique Continentale du Verre; Herr B. Simmingskold of the Glass Institute of Sweden; Prof. Dr. A. G. Smekal of the Deutsche Glastechnische Gesellschaft; Mons. A. Mathieu and Dr. Ivan Peyches of the Institute du Verre of France who were official hosts; General Director N. von Bulow of the Deutsche Glastechnische Gesellschaft; Prof. Dr.-Ing. J. A. de Artigas (Spain); and Mons. E. V. Borel (Switzerland). A number of other technologists were present by invitation to read papers. These included R. W. Douglas, Hon. Secretary of the Society of Glass Technology, who attended the 1951 meeting of the American Ceramic Society at Chicago.

JEANNETTE GLASS EMPLOYEEES DONATE TIME TO HELP REHABILITATE COMPANY

With their plant threatened with financial disaster, 600 employees of the Jeannette Glass Company are working for nothing until the factory is back on its feet. The five-acre plant was seriously damaged June 13 when a flash flood sent muddy waters over the property. Machinery was clogged, motors were jammed with mud, and thousands of glass dishes and tumblers were broken.

Damage was estimated at a half million dollars. In addition, a half million dollars worth of stock was broken. Members of the three union locals in the plant held a mass meeting where it was decided they would work eight days free. Each man will contribute one day's labor each week for eight weeks. The office force will take similar action.

Kirk W. Todd, President of the company, appeared at the mass meeting to express his appreciation.

A.S.T.M. TO CELEBRATE FIFTIETH ANNIVERSARY IN 1952

The American Society for Testing Materials, functioning as a committee from 1898 but officially incorporated as a national technical society in 1902, will celebrate its fiftieth anniversary during its 1952 week-long Annual Meeting in New York City, June 23 through 27.

J. GILBERT MOHR NAMED QUALITY CONTROL MANAGER OF NEW L-O-F FIBER GLASS DIVISION

G. P. MacNichol, Jr., Vice President of Libbey-Owens-Ford Glass Company, has announced the appointment of J. Gilbert Mohr as Quality Control Manager of the company's new Fiber Glass Division.

Mr. Mohr, formerly of the glass technology section of the Research Division of L-O-F, has been with the firm for nearly four years. Prior to that time, he was with Corning Glass Works as a research physicist, and in ceramics color technology work with the E. I. du Pont de Nemours & Company.

Mr. Mohr received his B.S. degree in ceramic engineering from Pennsylvania State College in 1937 and his M.S. in glass technology from Alfred University in 1943. He is a member of the American Ceramic Society, American Quality Control Society, the Society of Glass Technology, the American Institute of Ceramic Engineers, and Keramos. He is also listed in American Men of Science. He has authored several semi-technical articles for trade magazines dealing with glass and ceramics.

In his new duties, Mr. Mohr will be closely associated with Donald L. McClure, Plant Manager at Parkersburg.

G.C.M.I. TRUSTEES ELECTED AT RECENT MEETING

In the report of the recent Glass Container Manufacturers Institute meeting held at White Sulphur Springs, THE GLASS INDUSTRY omitted the names of the five new trustees who were elected at that time.

Chosen as trustees were Philip O'C. White, Secretary of White Cap Company; Bert W. Cremers, Vice President of Wyandotte Chemicals Corporation; William V. Fisher, President of Anchor Hocking Glass Corporation, who is a re-elected Trustee; J. Preston Levis, Chairman of the Board of Owens-Illinois Glass Company; and Joseph M. Nester, President and Treasurer of Obear-Nester Glass Company. Mr. Nester was elected to fill out the unexpired term of Lewis F. Gayner.

NEW NATIONAL BUREAU OF STANDARDS LABORATORY IN CALIFORNIA

The establishment of a new National Bureau of Standards laboratory center at Corona, California, to be devoted to various phases of electronic research, development and engineering has been announced by Dr. E. U. Condon, Director of the Bureau.

To be known as the Corona Laboratories, National Bureau of Standards, the new research center will be primarily concerned with technical problems of importance to the Department of Defense. Dr. R. D. Huntoon, formerly Chief of the NBS Atomic and Radiation Physics Division, has been named Associate Director to head the new laboratories.

Inventions and Inventors

Feeding and Forming

Press. Fig. 1. Patent No. 2,552,839. Filed Aug. 24, 1945. Issued May 15, 1951. Three sheets of drawings. Assigned to The British Heat Resisting Glass Company, Ltd., Bilston, England, by Arthur S. Brown.

This press is for the purpose of making articles, such as covers having knobs, without the use of split molds. The cover is first formed by the usual pressing operation in a mold 18 and ring 24, the knob 62 being in the form of a tapered stud with no undercut so that the plunger can be withdrawn. Another tool is then swung over the article and is lowered so that a pin 34 engages the top of the stud while a pair of arms 57 are closed on the stud to form the undercut knob. This avoids the seams formed by a split mold.

The patent contains three claims and the following references were cited: 463,646, Pease, Nov. 24, 1891; 519,113, Grebe, May 1, 1894; 1,159,853, Madden, Nov. 9, 1915; 2,335,419, Johnston, Nov. 30, 1943; 2,433,399, Roessler et al., Dec. 30, 1947; 339,479, France, Apr. 19, 1904; and 339,484, Great Britain, Dec. 11, 1930.

Take-out. Fig. 2. Patent No. 2,555,117. Filed March 10, 1949. May 29, 1951. Two sheets of drawings. Assigned to Fairmount Glass Works, Inc., by James E. Collins.

This take-out is for use with intermittent machines, such as the Lynch 10 or 16. A table 10 carries a set of molds 11. When the mold carrying the finished ware arrives at station B, the mold opens and the ware is grasped by one of four heads 16 mounted on a shaft 17 which is intermittently rotated so as to bring the ware over a blower pipe 30 where it dwells for cooling. The take-out moves through 90 degrees at each movement of the table and a second cooling pipe 32 may be provided after which the ware is deposited on a conveyor 29.

The patent contains three method claims and the references cited were 820,478, Croskey, May 15, 1906; 1,619,729, Howard, Mar. 1, 1927; 1,808,689, Stenhouse et al., June 2, 1931; 1,890,883, Morton et al., Dec. 13, 1932; 1,894,576, Tremblay, Jan. 17, 1933; 1,935,739, Freese, Nov. 21, 1933; 2,081,859, Peiler et al., May 25, 1937; and 2,180,737, Hess, Nov. 21, 1939.

Bulb Machine. Patent No. 2,556,237. Filed Aug. 18, 1944. Issued June 12, 1951. Five sheets of drawings, none reproduced. Assigned to Glafent Corporation by Henry F. Teichmann.

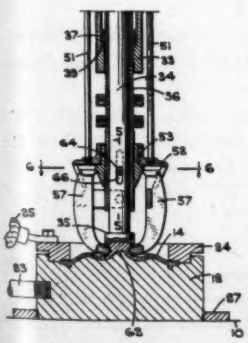


Fig. 1. Press.

This machine is of the type, sometimes called a "chain machine", in which an upper chain runs around a pair of sprockets on horizontal axes. This chain carries a series of mold parts and as they come under a feeder outlet, they are aligned with a set of moving funnels which direct a gob into the mold part. A plunger forms an indentation in the glass and as the chain goes onto the lower run, air is supplied to blow a blank.

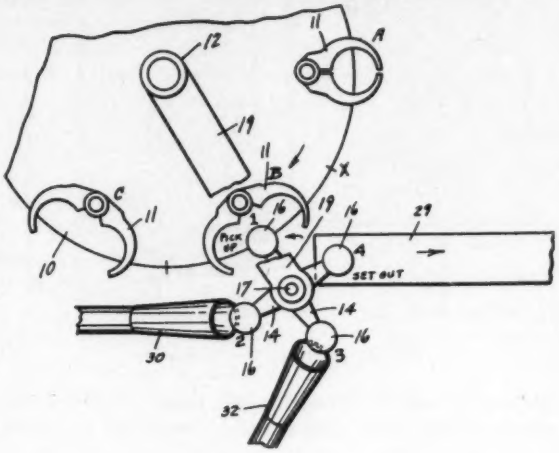


Fig. 2. Take-out.

The blank then is enclosed by a series of molds carried on a lower chain and the bulb is blown. The molds then open and the finished bulb is ready to be removed as the upper chain approaches the charging station again.

The patent contain five claims and 12 references were cited by the Patent Office.

Furnaces

Electric Furnace. Patent No. 2,552,395. Filed May 2, 1947. Issued May 8, 1951. Two sheets of drawings, none reproduced. Edouard Virgile Borel, Vevey, Switzerland, and Jean Alexandre Cardot, La Chapelle-Saint-Mesmin, France, assignors to Societe Anonyme des Manufacturers des Glaces et Produits Chimiques de Saint-Gobain, Chauny & Cirey, Paris, France.

This invention is shown as a pair of electrodes supported by opposite walls of a furnace and overlapping at the middle of the furnace. Naturally the current flows through the shortest path—that is, where the electrodes overlap—and so the glass at that point is heated the most. The patent shows numerous ways in which a pair of electrodes can be arranged in accordance with the invention.

The patent contains six claims and 16 references were cited by the Patent Office.

Hartford Batch Feeder. Fig. 3. Patent No. 2,556,467. Filed July 23, 1946. Issued June 12, 1951. One sheet of drawings. Assigned to Emhart Manufacturing Company by M. M. Cannon, Jr.

The feeder shown in the patent is, in general, of the well-known Hartford construction which is disclosed in Patent No. 2,471,336. A curved oscillating pusher 10 pushes the batch into the tank through a water-cooled jacket 19. Tanks are usually operated at a pressure slightly above atmosphere and there is a tendency for gas to back up into the incoming batch and to interfere with the operation of the batch feeder. In order to prevent this, a manifold 21 supplies a regulated air pressure to the batch just before it enters the tank and this prevents

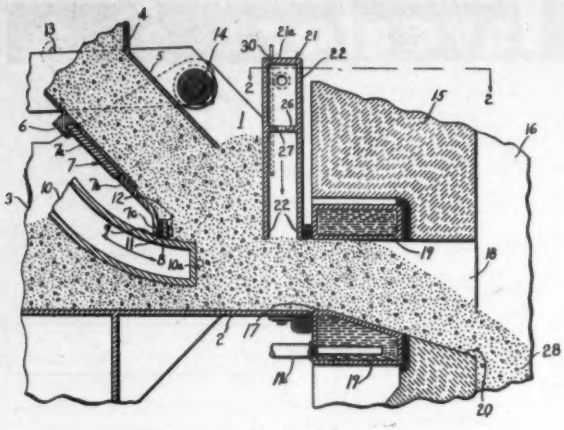


Fig. 3. Hartford Batch Feeder.

the gas and moisture from the tank from going back into the incoming batch and interfering with the operation of the batch feeder.

The patent contains two claims and references cited by the Patent Office were: 473,741, Hansen, Apr. 26, 1892; 1,500,651, Smith, July 8, 1924; 1,941,897, Hiller, Jan. 2, 1934; 1,953,427, Moorshead, Apr. 3, 1934; 1,999,761, Howard, Apr. 30, 1935; and 486,447, Germany, Nov. 25, 1929.

Glass Compositions

Titania-Containing Silicate Glass. Patent No. 2,554,952. Filed Sept. 12, 1946. Issued May 29, 1951. One sheet of drawings, none reproduced. Assigned to Holophane Company, Inc., by Isadore Mockrin and Arnold E. Pavlish.

This glass is particularly adapted for use in pressed reflectors. The single claim of the patent sets forth the composition as

	Per cent
SiO_2	57½
Na_2O	12
K_2O	6
BaO	9½
TiO_2	15

The references cited were: 1,362,917, Barton, et al., Dec. 21, 1920; 2,444,845, Perley, July 6, 1948; 92,338, Austria, 1923; and Eitel-Pirani-Scheel: Glastechnische Tabellen (1932), 662.

Sheet and Plate Glass

Bending Glass Sheets. Fig. 4. Patent No. 2,551,606. Filed May 28, 1948. Issued May 8, 1951. Five sheets of drawings. Assigned to Libbey-Owens-Ford Glass Company by J. E. Jendrisak.

This patent shows a bending mold and method of bending in which a sheet of glass is supported by its edges which are moved toward each other until the sheet nears its final shape, at which time it contacts a shaping mold and gets its final shape. The sheet 10 is positioned by small ceramic rollers 35 which engage the edges of the sheet. Other positioning devices engage the ends of the sheet. Molds 16 and 17 are below the sheet.

The device is heated in a furnace and pressure is applied to the edges by the rollers 35. As soon as the sheet softens, it sags toward the molds and this action is hastened by the pressure of the rollers 35. Thus the curved sheet is formed with little or no sliding action between the sheet and the mold.

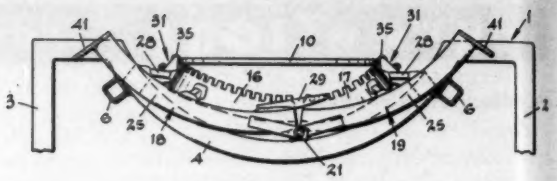


Fig. 4. Bending Glass Sheets.

The patent contains 14 claims and the references cited were 1,999,558, Black, Apr. 30, 1935; 2,330,349, Galey, Sept. 28, 1943; and 2,348,279, Boyles et al., May 9, 1944.

Bending Mold. Patent No. 2,551,607. Filed Dec. 31, 1948. Issued May 8, 1951. Two sheets of drawings, none reproduced. Assigned to Libbey-Owens-Ford Company by J. E. Jendrisak.

This mold is composed of a number of members having a surface shaped to form a part of the mold, these members being hinged together and suspended from a frame by links. It would appear that this device might be used with the machine of the preceding patent by the same inventor.

The patent contains eight claims and the references cited were 1,107,476, Barot, Aug. 18, 1914; and 2,330,349, Galey, Sept. 28, 1943.

Shaping Mold. Fig. 5. Patent No. 2,554,572. Filed Dec. 30, 1948. Issued May 29, 1951. Two sheets of drawings. Assigned to Libbey-Owens-Ford Glass Company by Joseph E. Jendrisak.

The figure is a side elevation of the mold showing a thin steel strip 4, the upper edge of which forms the shaping surface of the mold. This strip is supported on a series of slender posts 3, all of this being carried on a suitable base. Holes 5 are provided in the strips to retard the transmission of heat and thus allow the glass engaging edges of the strip to reach the same temperature as the glass. The edges of the sheet are supported by members 9 and 10. These members are carried by a linkage system so that they move inwardly as the sheet sags under heat. The sheets are supported in the final form by the marginal portions only.

The patent contains nine claims and the references cited were 760,959, Connington, May 24, 1904; 1,999,558, Black, Apr. 30, 1935; and 2,330,349, Galey, Sept. 28, 1943.

Tube and Cane Machines

Tube Cutting Machine. Fig. 6. Patent No. 2,553,136. Filed Jan. 18, 1950. Issued May 15, 1951. Two sheets of drawing. Charles Eisler, inventor.

This machine is for cracking off a series of short lengths of tube or cane from longer lengths which are placed in an inclined drum 11. These slide down against

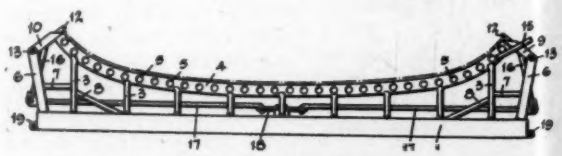


Fig. 5. Shaping Molds.

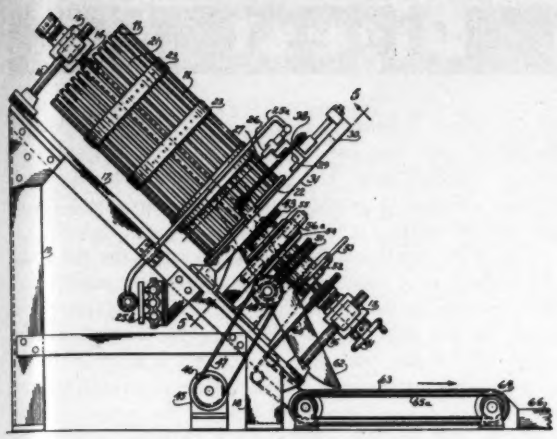


Fig. 6. Tube Cutting Machine.

a stop plate 22. A burner heats the tube at the place where the cut is to be made and the severance is made by a cutter arm 26 pressed against the tube by an adjustable weight. The severed pieces are then subjected to an annealing operation.

During these operations the tubes are rotated by a chain 38 which holds the short lengths until they are free from the chain when they fall into a chute 62 and then onto a conveyor 63. The whole apparatus is automatic and a large number of short exact lengths can be produced at high speed.

The patent contains two claims and the references cited were 1,262,567, Rippl, Apr. 9, 1918; 1,493,044, Leiman, May 6, 1924; 1,754,143, Brown et al., Apr. 8, 1930; 2,304,926, Juvinall, Dec. 15, 1942; and 619,965, Great Britain, Mar. 17, 1949.

Miscellaneous Processes

Burn-off Machine. Fig. 7. Patent No. 2,554,339. Filed March 28, 1949. Issued May 22, 1951. Six sheets of drawings. Assigned to Chamberlain, Inc., Chicago, Ill., by Ernest L. Lilja and Andrew Paterson.

The articles severed by this machine are tubular in form. The tube is placed in a carrier which is pivotally mounted and also movable vertically. After being placed in position, the carrier is lifted and turned through 90 degrees to bring the tube into vertical position. The carrier is then lowered to bring the bottom end of the tube into the position shown in the figure where the tube 8 is enclosed by the burner mechanism 10. This burner is hinged and after the tube is in position, it is closed about the tube. A switch is then thrown, the gas is ignited, and the burner mechanism rotates about the tube. All necessary adjustments are provided.

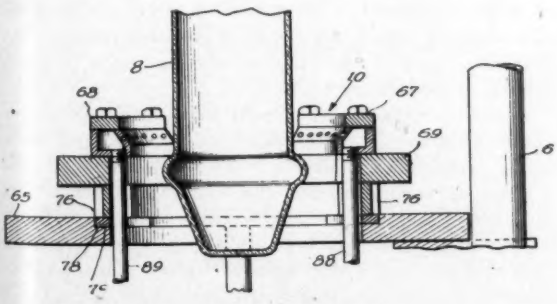


Fig. 7. Burn-off Machine.

The patent contains two claims and the following references were cited: 676,699, Roemisch, June 18, 1901; 684,686, Grotz, Oct. 15, 1901; 1,577,538, Parker, Mar. 23, 1926; 1,937,723, Sloan, Dec. 5, 1933; 2,215,980, Schreiber, Sept. 24, 1940; 2,361,824, Dorman, Oct. 31, 1944; 2,384,510, Volkman, Sept. 11, 1945; and "Modern Laboratory Appliances"; Copyright 1942, p. 226.

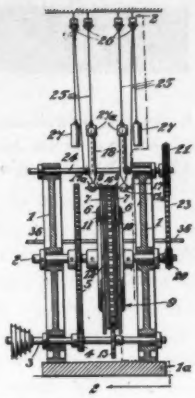


Fig. 8. Bead Forming Machine.

Bead Forming Machine. Fig. 8. Patent No. 2,555,893. Filed Apr. 30, 1948. Issued June 5, 1951. Two sheets of drawings. Paul Lebrun, Long Island City, N. Y., inventor.

A hopper contains a number of wires which drop into slots in two disks 7 and as the wires approach the top of the disks they are rotated by a spring band 16. At the top, molten glass from two rods 18 falls onto the rotating wires to form two beads. Later the wire in the beads is cut off and the wire remaining in the beads is dissolved by an acid bath.

The patent contains two claims and seven references were cited as follows: 601,062, Neuss, Mar. 22, 1898; 1,580,076, Paisseau, Apr. 6, 1926; 1,643,215, Koenig, Sept. 20, 1927; 1,709,524, Demers, Apr. 16, 1929; 2,234,976, Muntwyler, Mar. 18, 1941; 152,762, Germany, June 22, 1904; and 630,452, France, Dec. 3, 1927.

Orifice Ring Tool. Patent No. 2,550,335. Filed Dec. 15, 1948. Issued Apr. 24, 1951. One sheet of drawings, none reproduced. Assigned to Emhart Manufacturing Company by Francis N. Dailey.

Orifice rings are sealed in place by a clay luting between the adjacent refractory surfaces. In this invention the ring is supported on a freely rotatable holder and luting is forced from a grease gun onto the flange of the ring in such a direction that the discharging luting material causes the ring and holder to rotate thus laying a stream of luting around the flange of the ring.

The patent contains three claims and the references cited were 861,802, Brown, July 30, 1907; 997,172, Zimmerman, July 4, 1911; 2,203,572, Johnson, June 4, 1940; 2,270,075, Miller, Jan. 13, 1942; and 2,324,410, Miller, July 13, 1943.

Vacuum Bottle Machine. Patent No. 2,553,135. Filed Oct. 7, 1949. Issued May 15, 1951. Three sheets of drawings, none reproduced. Charles Eisler, inventor.

This is a turret type machine having 12 heads into which the outer blanks of vacuum bottles are placed, the bottom is pierced by a burner, and the exhaust tube is sealed to the blank. The machine provides for the necessary heating of the parts and the annealing.

The patent contains four claims and the references cited were 2,272,927, Stager, Feb. 10, 1942; 2,410,345, Hinkley, Oct. 29, 1946; 2,413,960, Eisler, Jan. 7, 1947; 2,414,587, Eisler, Jan. 21, 1947; and 22,105/35, Australia, May 9, 1935.

Research Digest

A Spectrophotometric Study of the Colors Given by Iron in Alkali-Lime-Silica and Alkali-Lime-Borosilicate Glasses

The chemistry of iron in glass has always been a subject of great interest to the glass technologist and the literature contains considerable information on this subject. The latest contribution is by Professor H. Moore and S. N. Prasad who report on a spectrophotometric study of the colors given by iron in alkali-lime-silica and alkali-lime-borosilicate glasses. Part I of their work dealing with the forms in which the iron exists in these glasses is reported in the December 1949 issue of the *Journal of the Society of Glass Technology*, while the August 1950 issue of the same *Journal* contains Part II dealing with reduction-oxidation equilibria in glasses as revealed by the colors given by iron and the influence of alumina on the color. This same issue also contains Part III of the report which deals with the effect of oxidizing agents on the color of glasses containing iron. Brief summaries of the conclusions reached by the authors are given below.

As a result of the work reported in Part I of this investigation, it was concluded that: (1) The coloring effect of iron in glasses may be due to iron in all three of the known states of oxidation of iron; namely, ferrous iron giving a rich blue color, ferric iron giving a rich amber, and ferroso-ferric iron giving an almost perfectly "neutral" gray. (2) Iron may also exist in glasses in a form in which it contributes no color whatever to the glass. (3) In the "colorless" form, the iron is present in the fully oxidized (ferric) condition. (4) The "colorless" ferric iron is not present in the form of a compound with the alkali of the glass as a ferrite or a ferrate, but is associated with the silica in the glass.

(5) The most probable condition of the "colorless" iron is that it exists as ferric iron atoms, each linked to corners of three adjacent SiO_4 tetrahedra in the glass structure. (6) The ferrous-ferric balance moves toward the state of higher oxidation as the proportion of iron is increased in a glass of given composition. (7) In all-soda glasses the iron is more strongly reduced than in soda-potash or all-potash glasses of corresponding compositions containing the same proportion of iron. (8) In the glasses containing moderately high proportions of boric oxide, the oxidation-reduction balance moves towards the state of higher oxidation.

In Part II it was concluded that: (1) The ferrous-ferric ratios obtained by color analysis and by chemical analysis show marked differences which suggest that even when all precautions are taken to prevent oxidation during the chemical analysis, some oxidation is inherent in this process, probably during the initial taking up of the glass into solution in the hydrofluoric acid mixture.

(2) The effects of prolonged founding have been investigated and show that, under given melting conditions, the ferrous-ferric balance in the glass is not usually greatly affected, and in some cases not at all, by prolongation of the founding period, the balance being determined primarily by the composition of the glass, i.e., by the proportions and nature of the alkali constituents of the glass. Increased reduction with prolongation of founding time was noticeable in glasses containing the mixed alkalies, soda, and potash, and in the all-potash glasses containing potash molecularly equivalent to 17 per cent of soda.

(3) With small amounts of lithia replacing the soda, the reduction is greater than in the corresponding all-soda glasses, as would be expected from the greater mobility of the lithium ions. With lithia contents of the order of 8-9 per cent, however, there is some evidence of a swing back towards a higher state of oxidation, and this tendency becomes marked when the proportion of lithia is still further increased. With high proportions of lithia there is an appreciable increase in the ferric color and a very considerable increase in the gray absorption attributed to ferroso-ferric oxide.

(4) The introduction of the trivalent oxides B_2O_3 and Al_2O_3 increases the proportion of iron contributing the gray (neutral) color attributed to ferroso-ferric oxide. The gray component appears to be increased in the ratio of the molecular proportions of the amounts of B_2O_3 and Al_2O_3 added, though the evidence available is too meager for this relationship to be regarded as satisfactorily established.

In Part III a study was made of the effects produced by introducing various oxidizing agents into the glass batches, including sodium nitrate, arsenious oxide used alone and with sodium nitrate, antimony trioxide alone and with sodium nitrate, manganese dioxide, and cerium dioxide.

The effects of sodium nitrate are to diminish the proportion of the ferrous, and to increase considerably the proportion of "colorless" iron in the glass, with a small increase in the ferric color and a slight diminution in the intensity of the ferroso-ferric gray. Arsenious oxide has similar effects, the color changes produced by 0.5 per cent of arsenious oxide being somewhat larger than those resulting from the use of sodium nitrate in the proportion 2.5 parts per 100 parts of sand in the batch. With sodium nitrate the effect of using 20 parts per 100 parts of sand is very little greater than the effect obtained with 2.5 parts. With arsenious oxide also, the effect obtained with 0.5 per cent is nearly as large as that produced by increasing the proportion to 2 per cent.

When arsenious oxide and sodium nitrate are used together, each enhances the effect due to the other. With 0.5 per cent of As_2O_3 and 2.5 parts $NaNO_3$, the intensity of color is reduced to about three-quarters of the intensity obtained with 2 per cent of As_2O_3 alone, and to less than two-thirds of the intensity obtained with 20 parts $NaNO_3$ in the absence of As_2O_3.

Antimony trioxide, when used alone, has only a very slight effect on the colors produced by iron, and when small proportions (under 1.5 per cent) are used with 5 parts of sodium nitrate, the combined effect is *less* than would be produced by the nitrate alone. With 2 per cent of Sb_2O_3 and 5 parts of $NaNO_3$, the effect is greater than that obtained with 5 parts of $NaNO_3$ alone, and the effect is further increased if the proportion of Sb_2O_3 is raised to 3 per cent.

Manganese dioxide added to the batch reduces the proportion of ferrous iron and causes some increase in the proportion of colorless iron. At the same time, however, it causes marked increases in the intensity of the ferric color and of the ferroso-ferric gray, as a result of which there is no general increase in the over-all transmission in the visible region. The effect of adding maganese dioxide in increasing proportions is to change the color progressively from blue or greenish-blue through green and yellow-green to a rich "ferric" amber, with pink streaks developing in the glass if the proportion of manganese is still further increased. The marked increase in the ferric color and in the ferroso-ferric gray can be explained on the assumption that trivalent manganese is able to displace ferric iron linked into the glass structure in the colorless form, with the liberation of energy. A similar explanation was put forth to account for the very considerable development of ferroso-ferric gray in glasses containing fairly large proportions of B_2O_3 or Al_2O_3. In the glasses containing manganese dioxide, however, the reduction of the displaced ferric oxide to the ferroso-ferric condition would not occur to nearly the same extent as in the high boric oxide or highly aluminous glasses.

Cerium dioxide has a much more marked oxidizing action and produces a higher proportion of colorless iron than any of the other oxidizing agents used in this investigation, provided that melting is carried out at temperatures not appreciably higher than 1400°C. If the temperature of melting is raised to 1450°C., however, the effect is very greatly diminished, presumably due to the instability of cerium dioxide at temperatures of the order of 1420-1440°C.

The "decolorizing" processes used for minimizing the coloring effect of small quantities of iron in glasses depend primarily on the iron being maintained as far as possible in the fully oxidized condition in order that it may become linked into the glass structure in the colorless form. Arsenious oxide and sodium nitrate used together form a highly effective combination for this purpose at a comparatively low cost. The selenium and cobalt oxide, commonly used with arsenic and nitre in decolorizing mixtures, do not play any essential part in the true "decolorizing" process. They introduce additional absorptions (i.e., additional color) which "correct" any residual green or yellowish-green color in the glass and so give the glass a slight neutral or gray color.

WYANDOTTE NAMES DIRECTOR OF DEVELOPMENT

Henry C. Speel has been appointed Director of the Development Department of Wyandotte Chemicals Corporation, according to a recent announcement.

Formerly with General Dyestuffs Corporation, Mr. Speel has had extensive experience in market research and market development work over the last 20 years with Atlas Powder Company, General Mills, Inc., Alrose Chemical Company, and General Aniline and Film Corporation. He is the author of a number of technical articles on polyhydric alcohols, surface active agents, natural colloids, pharmaceutical and cosmetic chemicals, and textile processing auxiliaries—all products which are under investigation in the expanding organic chemical program at Wyandotte Chemicals Corporation.

Mr. Speel will direct all phases of market development and technical service for Wyandotte Chemical's new organic products.

ANCHOR HOCKING APPOINTMENTS

Anchor Hocking Glass Corporation has named James W. Sharpe as Plant Manager of its Winchester, Indiana, glass container factory. Mr. Sharpe was formerly Plant Manager of the firm's container factory at Connellsville, Pa.

Also announced was the appointment of Harris Snell, formerly Assistant Plant Manager of the Connellsville plant, as Plant Manager to succeed Mr. Sharpe. To replace Mr. Snell has been named Robert E. Deetz, formerly Production Control Manager for the Container Division of Anchor Hocking.

PITTSBURGH CORNING DEVELOPS DAYLIGHTING NOMOGRAPH

Officials of the Pittsburgh Corning Corporation have announced the development of the PC Daylighting Nomograph which makes possible the prediction of daylighting levels in a room before the building is constructed. Extensive work at the Pittsburgh Corning Daylighting Research Center has made this contribution possible.

Through the careful study of functional glass block and window performance in existing buildings and in the laboratory under a wide variety of conditions, scientists at the Research Center have been able to compile the data which served as a basis for the Nomograph. Information required to make the daylighting prediction can be obtained from the architect's plans and local weather bureau records.

WESTINGHOUSE TO MAKE GLASS BULBS IN HOT SPRINGS

The Westinghouse Electric Corporation has announced plans to build southeast of Hot Springs, Ark., a glass plant that will make bulbs for incandescent lamps.

The company manufactures glass tubes for fluorescent lamps and small diameter glass tubing for incandescent lamps in Fairmont, W. Va., but until now it has bought all its light bulb blanks from glass manufacturers.

"Our sales have more than tripled in the last 10 years, a volume which makes it advantageous to have our own bulb plant," Ralph C. Stuart, vice president in charge of the Westinghouse Lamp Division, said at a meeting recently held in Hot Springs.

The 30-acre plant, located on the shore of Lake Catherine, will employ 500 men and women. It will serve as a feeder for the company's lamp manufacturing plant in Little Rock, Ark. Mr. Stuart said the Hot Springs site is close to the sources of sand, limestone, soda ash, and other raw materials required for glassmaking. A one-floor structure of brick and steel, containing 300,000 square feet of floor space, will be built on the property.

Current Statistical Position of Glass

Employment and payrolls: During April 1951 employment in the glass industry rose to reach a preliminary 132,200. During March, employment was an adjusted 130,400. This represents a difference of about 1 per cent. During April 1950, employment was 112,700, or 17 per cent below April this year.

Glass manufacturers, during April 1951, paid out a total of $36,795,226 in payrolls. Compared with the adjusted payrolls for March of $37,599,536, a drop of 2 per cent is indicated. Payrolls during April 1950 were $28,939,625, or 28 per cent below this year.

GLASS CONTAINER SHIPMENTS

(All figures in Gross)

Narrow Neck Containers

	May 1951
Foods	999,160
Medicinal & Health Supplies	1,299,171
Chemicals, Household & Industrial	740,144
Beverages, Returnable	782,248
Beverages, Non-returnable	20,301
Beer, Returnable	779,415
Beer, Non-returnable	688,351
Liquors	647,594
Wines	232,008
Toiletries & Cosmetics	627,097
Sub-total (Narrow)	6,815,489

Wide Mouth Containers

Foods	2,522,944
Dairy Products	270,579
Home Canning	*
Medicinal & Health Supplies	346,145
Chemicals, Household & Industrial	138,290
Toiletries & Cosmetics	153,665
Packers' Tumblers	143,183
Sub-total (Wide)	3,574,806
Total Domestic	10,390,295
Export Shipments	312,057
TOTAL SHIPMENTS	10,702,352

* This figure included with "Wide Mouth, Foods".

GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in Gross)

		Production May 1951	Stocks May 1951
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck	3,847,996	3,341,040
	Wide Mouth	3,380,526	3,612,709
Dairy Products		256,362	278,353
Home Canning		*	*
Beverages, Returnable		857,109	667,208
Beverages, Non-returnable		21,634	26,010
Beer, Returnable		854,349	236,466
Beer, Non-returnable		680,337	189,775
Liquors		580,803	654,589
Wines		235,339	289,738
Packers' Tumblers		134,750	130,494
TOTAL		10,849,205	9,426,382

* This figure included with "Wide Mouth, Foods".

Glass container production during May 1951, based on figures released by the Bureau of Census, dropped 2 per cent from the 11,075,359 gross produced during April. May production was 10,849,205 gross. During May 1950, production was 9,377,251, or 18 per cent below May this year. Total glass container production thus far in 1951 has reached a total of 52,390,618 gross. Compared with production of 41,285,735 gross produced during the corresponding period in 1950, production for 1951 is running close to 27 per cent ahead of last year.

Shipments of glass containers during May 1951 established a new second high for a single month with a total of 10,702,352 gross. Compared with April shipments of 9,847,909 gross, May shipments increased almost 9 per cent. Glass container shipments during May 1950 were 9,643,330 gross, or 10 per cent less than for May this year. At the close of the first five months of 1951, glass container manufacturers have shipped a total of 49,564,831 gross. At the same time in 1950, shipments had reached a total of 40,324,868 gross, indicating that 1951 shipments are close to 23 per cent ahead of last year.

Stocks on hand at the close of May 1951 rose about 1 per cent from the 9,293,375 gross on hand at the close of April to reach 9,426,382 gross. Stocks on hand at the close of May 1950 were 9,714,487 gross.

Automatic tumbler production fell a little more than 3 per cent during May 1951 to reach 7,292,106 dozens. During April, production was 7,533,507 dozens. Production during May 1950 was 6,590,980 dozens. Shipments of automatic tumblers also dropped somewhat and were 6,759,720 dozens. This is about 1 per cent less than the 6,851,240 dozens shipped during April. Shipments during May 1950 were 6,222,662 dozens. Stocks on hand at the close of May 1951 were 11,381,190 dozens, or 4 per cent more than the 10,932,953 on hand at the end of April. Stocks on hand at the end of May 1950 were 10,236,958 dozens.

Table, kitchen, and household glassware: Manufacturers' sales of machine-made table, kitchen, and household glassware during May 1951 remained somewhat the same as for April and were 3,407,828 dozens. Compared with April sales of 3,438,850 dozens, a drop of almost 1 per cent is indicated. Sales during May 1950 were 3,393,502 dozens. At the close of the 12-month period ending May 1951, manufacturers have sold a total of 40,926,484 dozens. This is almost 5 per cent more than the 39,015,425 dozens sold during the corresponding period in 1950.

Pressed and blown glassware: According to a 1950-1949 comparison just released from the Bureau of Census, factory shipments of pressed and blown glassware (*except glass containers*) totaled $324,700,000 in 1950, an increase of 34 per cent over 1949. Shipments of machine-made table, kitchen, art, and novelty glassware in 1950 were valued at $72,500,000, up 15 per cent over 1949. Lighting glassware, including substantial ship-

ments of television tube blanks and parts, total $133,300,000, a 73 per cent gain over 1949. Cooking ware showed a 30 per cent increase, but handmade table, art, and novelty glassware declined 4 per cent from 1949. Shipments in 1950 of all other pressed and blown glassware (*except glass containers*) amounted to $78,400,000, up 24 per cent over 1949.

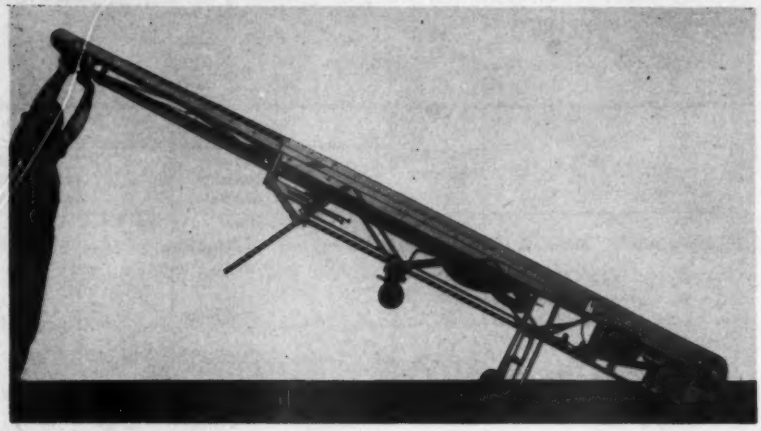
The table shown below gives detailed statistics on the quantity and value of shipments of this glassware by product.

Product	Unit of measure	1950		1949	
		Quantity	Value (thousands of dollars)	Quantity	Value (thousands of dollars)
PRESSED AND BLOWN GLASSWARE (EXCEPT GLASS CONTAINERS), TOTAL	...	...	$324,696	...	$242,418
Machine-made table, kitchen, art and novelty glassware (including glassware made by machines with automatic and semi-automatic feeds), total	...	...	72,493	...	63,023
Tumblers, goblets, and other stemware	M dozen	71,884	38,273	58,140	31,596
Tableware (designed for serving food and drink; excluding tumblers, goblets, and other stemware)	do.	27,162	19,108	28,927	18,446
Kitchenware (designed for preparing and storing food in homes and commercial establishments; excluding cooking ware)	do.	7,769	10,310	*7,502	9,060
Ornamental, decorative, and novelty glassware; and smokers' accessories	do.	6,350	4,802	*5,532	3,919
Hand-made table, art, and novelty glassware, total	...	...	29,510	...	30,737
Pressed ware:					
Tumblers, goblets, and other stemware	M dozen	512	1,825	566	2,024
Tableware (excluding tumblers, goblets, and other stemware)	do.	1,111	8,566	1,303	8,720
Ornamental, decorative, and novelty glassware; and smokers' accessories	...	...	3,378	...	3,837
Blown ware:					
Tumblers	M dozen	645	1,866	808	2,087
Goblets and other stemware	do.	1,774	10,035	1,814	10,613
Ornamental, decorative, and novelty glassware; and smokers' accessories (including ornamental tableware)	...	...	3,840	...	3,456
Cooking ware (heat-resistant, heat-treated, and annealed), total	...	...	10,977	...	8,436
Hand-and machine-made coffee and beverage makers (excluding tea kettles) 1/	M pieces	54,608	10,977	2,962	8,436
Machine-made custard cups, cake and bread bakers, casseroles, pie plates, and other machine-made and hand-made cooking ware (including top-of-stove ware)				41,767	
Lighting glassware, total	...	...	133,268	...	76,956
Bowls, all types	...	...	3,316	...	2,805
Enclosing globes, all types	...	...	3,570	...	2,953
Shades, reflectors, and torcheres	...	...	5,887	...	5,184
Lantern globes (oil and electric)	M dozen	426	889	354	613
Lamp chimneys	do.	1,317	1,300	1,109	994
Lamp parts	...	...	2,970	...	1,985
Railroad, marine, and traffic lighting glassware	...	...	888	...	1,045
Shields and plates for fluorescent lighting fixtures	...	...	434	...	381
Electrical discharge tubing (including fluorescent and neon)	M linear feet	423,104	6,850	334,698	5,240
Electric-light bulb blanks, electronic-tube blanks (including radio, X-ray, radar, and special tubes), and television-tube blanks and parts	...	...	102,201	...	51,661
Other interior and exterior lighting glassware (including oil founts and prisms)	...	...	4,963	...	4,095
All other pressed and blown glassware, total	...	...	78,448	...	63,266
Technical and scientific glassware:					
Tubing (excluding fluorescent and neon); rods and canes (all types)	M pounds	70,620	15,972	52,469	11,937
Insulators and other technical glassware, except electronic tube blanks	...	...	1,790	...	1,359
Industrial glassware, including gauge glass, instrument faces, machine parts, glass knobs, meter covers, pumps, battery jars, etc.	...	...	11,474	...	8,724
Other pressed and blown glassware:					
Machine-made (including glass block; scientific and laboratory glassware; sun-glass lenses and other eye-protective lenses; Christmas tree ornaments; stationers' ware, marbles, nursery bottles, lantern and searchlight lenses, automotive lenses, including sealed beam, ophthalmic lens blanks, optical-instrument lens blanks, etc.)	...	...	47,434	...	39,725
Hand-made (including kitchenware other than cooking ware, stationers ware, and nursery bottles)	...	...	1,778	...	1,521

* Revised.

1/ Represents complete units only. Replacement parts are included in other cooking ware.

New Equipment and Supplies



NEW LIGHTWEIGHT ADJUSTOVEYOR

Stewart-Glapat Corporation, Zanesville, Ohio, has introduced a new lightweight Adjustoveyor which is a companion unit to the basic model which they announced last year. The unit is designed for applications not requiring the extreme lengths and massive load carrying capacity of the regular Adjustoveyor, but retains most of the basic and unique features of the large unit.

Construction features heavy truss designed to carry a total weight of 850 lbs. and a maximum unit weight of 300 lbs., plus a ball bearing mounted roller bed on which the belt rides. The unit measures 10′ closed and 17′6″ fully extended, and can be operated at any distance in between. It will stack to a height of 10′ at a maximum stacking angle of 30°.

BREAK-RESISTANT CUTTING BLADE

Clipper Manufacturing Company, 2800 Warwick, Kansas City 8, Missouri, is distributing its new Clipper "B-R" (Break-Resistant) Abrasive Blade which, it is stated, will not be damaged by dropping, twisting in the cut, or bending.

The new blade is manufactured in layers of glass fiber cloth impregnated with resins and silicone carbide. This material is then pressed together under hydraulic pressure and processed in kilns where the temperature is scientifically controlled to insure a resilient and tough blade. Its most effective performance is in the softer range of materials such as limestone, sandstone, light aggregate concrete products and dry press refractories, transite, etc. For harder materials, Clipper metal bonded diamond blades are suggested.

UNIVERSAL PRECISION GLASS CUTTING MACHINE

Moriki Saito, Aza Meyasu, Ikaruga-cho, Iokoma-gun, Nara prefecture, Japan, has recently developed a Universal Precision Glass Cutting Machine which can cut glass or ceramic in round bars, pipes, flat sheets, or any other shapes in any manner and direction desired. For instance, round glass bars, 3/8″ to 1″ diameter, can be cut within 10 seconds, while glass tubes, 2″ to 4″ diameter x 6 mm. thick, can be cut in 30 seconds.

The machine is said to give a perfect, clean cut by means of a wheel of 0.5 mm. thick, eliminating the need of refinishing the section. Thin, flat materials can be cut in several folds. The machine comes in two models: one for cutting flat materials and one for cutting round materials.

DIAMOND TOOTH BAND

The DoAll Company, Des Plaines, Illinois, has announced a new Diamond Tooth Band which is said to be capable of cutting directly to a desired contour, making possible a saving of valuable material which is removed in sections rather than in chips.

Suitable for refractory, ceramic, vitrified, vitreous, and geological materials, the new tooth band eliminates the conventional method of shaping the material to form by multiple cuts with diamond wheels or successive rough and finish contour grinding operations.

The diamond tooth bands are manufactured with precision accuracy to provide surface smoothness and fine tolerance cutting on glass, firebrick, carbon, marble, etc. Operating speeds range from 3,000 to 8,000 feet per minute, depending on the type of material being cut. Coolant must be flushed around the cutting edge of the diamond tooth band in order to wash away particles of material cut.

The entire drive mechanism runs off a standard drive shaft which powers the various units of the machine, which power unit incorporates a brake for quick stopping of the machine. Various type variable speed drives will be optional.

CATALOGS RECEIVED

Minnesota Mining and Manufacturing Company, 900 Faquier Street, St. Paul 6, Minn., has announced a new 16-page booklet, "The 3M Method", which illustrates how a two-step belt grinding operation speeds the grinding and polishing of safety, plate, and table-top glass.

The booklet shows how the method surpasses grinding jobs done with unsupported belts, loose grain mills, and diamond wheels. It also shows how the method makes it possible to cut costs, increase production, and double belt life. The booklet further shows how the method makes it possible to obtain better finishes faster, cut labor costs per job, reduce edge chipping, and reduce operator fatigue.

Patterson-Kelley Company, Inc., 376 Lackawanna Avenue, East Stroudsburg, Pa., has made available a complete and informative 4-page catalog, Number 402, describing its 4- and 8-qt. p-k Twin-Shell Laboratory Dry Blenders.

The new mixing principle is described and shown step by step through a series of unretouched photographs, and ending up with an intimate thorough blend. The laboratory blenders give the same performance as the larger production models ranging up to 250 cu. ft. working capacity. Features and special shells are also explained and illustrated.

The Hays Corporation, Michigan City, Indiana, has released a new, functionally designed, fully indexed bulletin on the Hays line of draft and low pressure instruments. It discusses indicators (of seven types), recorders, and controllers.

A two-page application table is included to aid the reader in selecting the correct instrument for his conditions. Features such as calibrating springs, diaphragm units, and differential valve assemblies are explained. Size, scales, ranges, cases, etc., of each instrument are illustrated and discussed. In addition, 14 types of draft and pressure, differential, and other measuring elements are shown.

Norton Company, Worcester 6, Mass., in its April 1951 house organ "Grits and Grinds", features "diamond wheels in the glass industry—hand pencil edging". The article describes the method used for producing a pencil edge, making use of an all-purpose glass-edging machine, which is illustrated.

The use of diamond wheels in glass grinding is then discussed with an illustration of hand pencil edging with Norton diamond wheels.

VISCOSITY

BORAX... a small quantity of B_2O_3 in the glass batch will assist in obtaining the proper viscosity.

Another good reason why Borax should be used as an essential ingredient in the container batch formula.

• • •

Our representatives are prepared to discuss all the special advantages of B_2O_3 in glass.

PACIFIC COAST BORAX CO.

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(*Continued from page* 350)

is still called for, based upon shapes, decorative motifs, color, chemical constituents, technical handling, migration of ideas, literary references, and representations of glass in pictorial art of the various periods. Chemical analyses and technical study are particularly desirable, but often the risk of damage involved precludes definitive examination.

That glass vessels were known and honored in the periods from T'ang to Ch'ing we have proof in their representation in Chinese frescoes and other paintings. The painters seem to have been fascinated by the delicacy and transparency of glass and to have taken delight in showing these qualities. These representations in painting offer a field in which research should be well rewarded for, if an actual glass vessel corresponds in shape and appearance with one shown in a painting and the date of the painting can be assigned with confidence, we have therein at least a clue to the possible date of the glass specimen.

With the Ch'ing Dynasty (1644-1912 A.D.) we are upon firmer ground. We find, chiefly from the records and letters of Jesuit missionaries, that the seventeenth century Jesuits introduced European glass and European methods. In 1680 the Emperor K'ang Hsi established, among other workshops, a glasshouse. Chinese glass thenceforward was not unlike European glass basically, but, in general, the manipulation of the metal differed radically. The Chinese artisans, since at least the twelfth century B.C., had been skilled lapidarists, working in jades and other stones. Perhaps they looked upon glass as but another mineral and as a matter of course took to carving it. At least, they finished it by carving even when the main shape may have been shaped in a mold (Fig. 6). They produced glass in the admired color tones of lapis and amber and jade. They also simulated in their glass the beautiful tones of their ceramic glazes. And they developed the overlay, or "cameo", process, usually employing two colors but occasionally more. This technique they frequently handled with notable delicacy and skill (Fig. 7). From this Ch'ing Dynasty numerous specimens are extant—vases, bottles, bowls, plates, platters, basins, boxes, ceremonial scepters, mosque lamps, snuff bottles, molded beads, cap ornaments, buckles, rings, bracelets, toy musical instruments, and other forms. The majority are patently of native origin, but there are also many "problem" pieces, some of which may be importations from Europe.

In our time, the period of the Republic, the industry has continued. The glass metal is fabricated primarily at Po-shan in Shantung Province and transported to Peiping in blocks, where it is worked and polished to produce examples which are often of considerable beauty. In recent years there has been a lively business in skillful imitations, in inexpensive glass, of rare jades, and other venerated stones. Figure 8 shows a modern glass ring which successfully imitates the effect of fine green and white jade.

The history of Chinese glass extends over possibly twenty-five centuries. It is impossible here to do more than merely suggest some of the stimulating aspects of a study of its development and some of the intricate problems which confront us today concerning that development. Gaps in our present knowledge are many. There is especial need of cooperation between the scientists and the students of Chinese art for technical examination and analyses, and for more comprehensive comparative studies along aesthetic lines. But several points stand out conspicuously. The Chinese never "took" to blowing glass. Except in the early imitations, in the Ch'ing Dynasty, blowing, when employed, was apparently chiefly a preliminary step to cutting. The Chinese flair was for molding and for intimate, personal carving. Traditional shapes and motifs long dear to the Chinese craftsmen in other media, specifically ceramic wares, were continued in glass.

Fig. 8. Glass Ring of the Present Day. Green and white, imitating jade. $1\frac{5}{16}$" diameter. *Courtesy of The Toledo Museum of Art, Toledo, Ohio.*

In spite of foreign influences Chinese glass has, in the main, retained its own individual flavor and charm. Qualities inherent in glass are not far removed from spiritual values, and values of the spirit have always been revered in Chinese culture. The Chinese, when they first became acquainted with glass, must have admired its translucency and transparency, its fragility and color, and revered it for an eternal quality of shimmering light that could stir the soul. The root radical of the Chinese written character for glass means "jewel" or "gem". In that respect it was early classed with jade, with lapis, and other venerated substances—the "precious things". Rather than a substance for practical use, as with us, it remained essentially an ornamental medium for vases and jewels and decorative accessories, and even for honored burial in the tomb.

Note: Dr. Frederick R. Matson, of The Pennsylvania State College, has examined some of the early Chinese beads owned by The Toledo Museum of Art and discussed in this article. It is hoped that he will find some early opportunity to publish his recordings.

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1. cf. W. Perceval Yetts, "The Shang-Yin Dynasty and the An-Yang Finds"; Journal of the Royal Asiatic Society (London), July 1933. Pl. IX and pp. 681-682.
2. These beads will be mentioned again in a discussion of glass from Korea.
3. cf. "Exhibition of East Asiatic Glass", The Toledo Museum of Art, Toledo, Ohio, October 1948, No. 84.

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(*To Be Continued*)

RUSSIAN TRANSLATIONS . . .

(*Continued from page* 357)

This was on the

10th	30th	60th	90th	110th	140th	and
24.1	24.7	25.1	24.5	24.9	25.5	and

200th day of operation
26.0 hours.

The percentage of rejects was 3% on the 10th and 8-9% on the 200th day of operation. The only cause of rejects was "stones" from the refractory roof of the tank.

The light transmission was 90.0-90.3% for 1 cm. during the whole operation. The tank could be used without repair for 1.5-2 years.

TABLE III

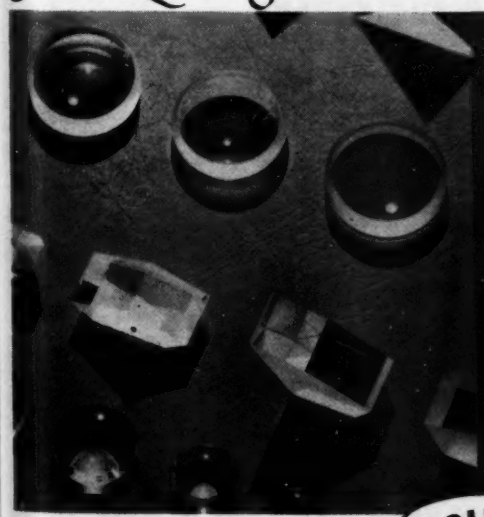
		Al_2O_3	Fe_2O_3
On the	10th day of operation	1.91	0.08
	40th	1.92	0.08
	70th	1.99	0.09
	100th	2.15	0.08
	160th	2.11	0.09
	200th	2.08	0.085

SOUTH AFRICAN GLASS COMPANY EXPANSION

Robert Adamson, formerly with Union Glass, Ltd., Natal Africa, and now Managing Director of the Consolidated Glass Works, Ltd., Germiston, Tvl., South Africa, has just completed a two weeks tour in the United States in connection with important plant expansions planned for his company.

It is reported that Consolidated Glass, formerly producing container ware only, will soon start production of tableware.

For Fine Glass ...
for Quality **OPTICAL GOODS**



SOLVAY
POTASSIUM CARBONATE

Dustless Calcined
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99-100% K_2CO_3

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83-85% K_2CO_3

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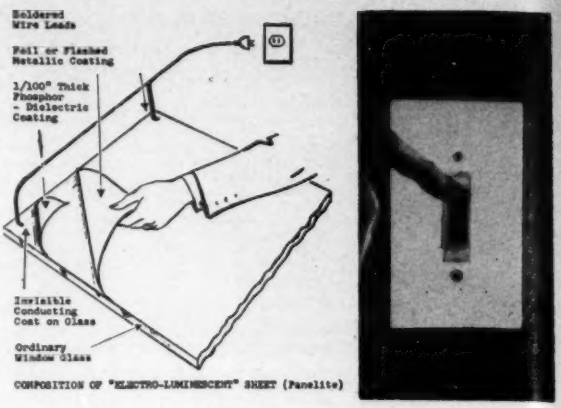
"PANELITE" ANNOUNCED BY SYLVANIA ELECTRIC

The development of a new method of producing light, entirely different from either incandescent or fluorescent light, has been announced by Sylvania Electric Products, Inc. Technically called electro-luminescence lighting, the general term for the new development is "Panelite".

Dr. E. F. Lowry, head of the Sylvania development group which perfected the new lighting principle, revealed that the new type of lamp consists of a special sheet of conductive glass on which is placed a "phosphor-dielectric" coating and a layer of vaporized aluminum, except for a narrow strip around the edge of the plaque. These two coatings add less than a hundredth of an inch to the glass itself, thereby achieving almost the ultimate in thinness. Wires are connected to the edges of the sheet to pick up current directly from 110-volt, 60-cycle house current. Under this condition, the brightness of the sheets is said to be more than enough for night clocks, roughly comparable with bright moonlight on a white object.

Aside from the advantage of the thinness of the application of the materials which make the luminescence possible, a second basic characteristic is that the light produced is uniform. Variations which exist in the luminosity are usually beyond the ability of the eye to discern readily. Thirdly, for most applications, it is the coolest of all sources. It has no cathode or filament concentration and all the energy is uniformly absorbed and radiated over the entire area making the temperature increment a minimum.

Commercial availability of Panelite is at present limited to two types. One type presents a green luminosity at 0.1 footlambert when the lamp is connected direct to the usual 120 volt, 60 cycle circuit. The second type is a green luminosity not over 2.0 footlamberts when a 500 volt step-up transformer is made part of the circuit. The primary difference between these commercially available panelites lies in the thickness and character of the dielectric used since, as with any condenser, there must be voltage breakdown protection for surges and line fluctuations.


Soldered Wire Leads
Foil or Flashed Metallic Coating
1/100" Thick Phosphor - Dielectric Coating
Invisible Conducting Coat on Glass
Ordinary Window Glass
COMPOSITION OF "ELECTRO-LUMINESCENT" SHEET (Panelite)

The spectrophotometric curve of the green panelite shows a rather saturated color peaking of 5200 angstroms. If, instead of standard 60 cycle circuits, energy can be supplied at higher frequencies to a green panelite, the brightness of the lamp would increase appreciably (about 12 fold at 3000 cycles) and the color would shift somewhat to the blue. This shift is on the order of 200 angstroms from the 5200Å peak.

Full Color Decorations—Fired On Glass

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Add color-bright sales appeal to your product or package with New Meyercord Thermo-Cals. For the first time you can apply *any number* of colors in fine registration with one simple operation—by hand or automatic machine. Thermo-Cals open a whole new area of sales and merchandising—beyond the limitation of stencils and at a fraction of handpainting cost. Thermo-Cals have a depth of color, luster and opacity never possible before, yet meet the most rigid caustic soda tests. They are easily applied to irregular shapes—even on convex or concave surfaces. Investigate Meyercord Thermo-Cals NOW for mass production artistry on your products or packages. Complete design and art facilities, technical service FREE!

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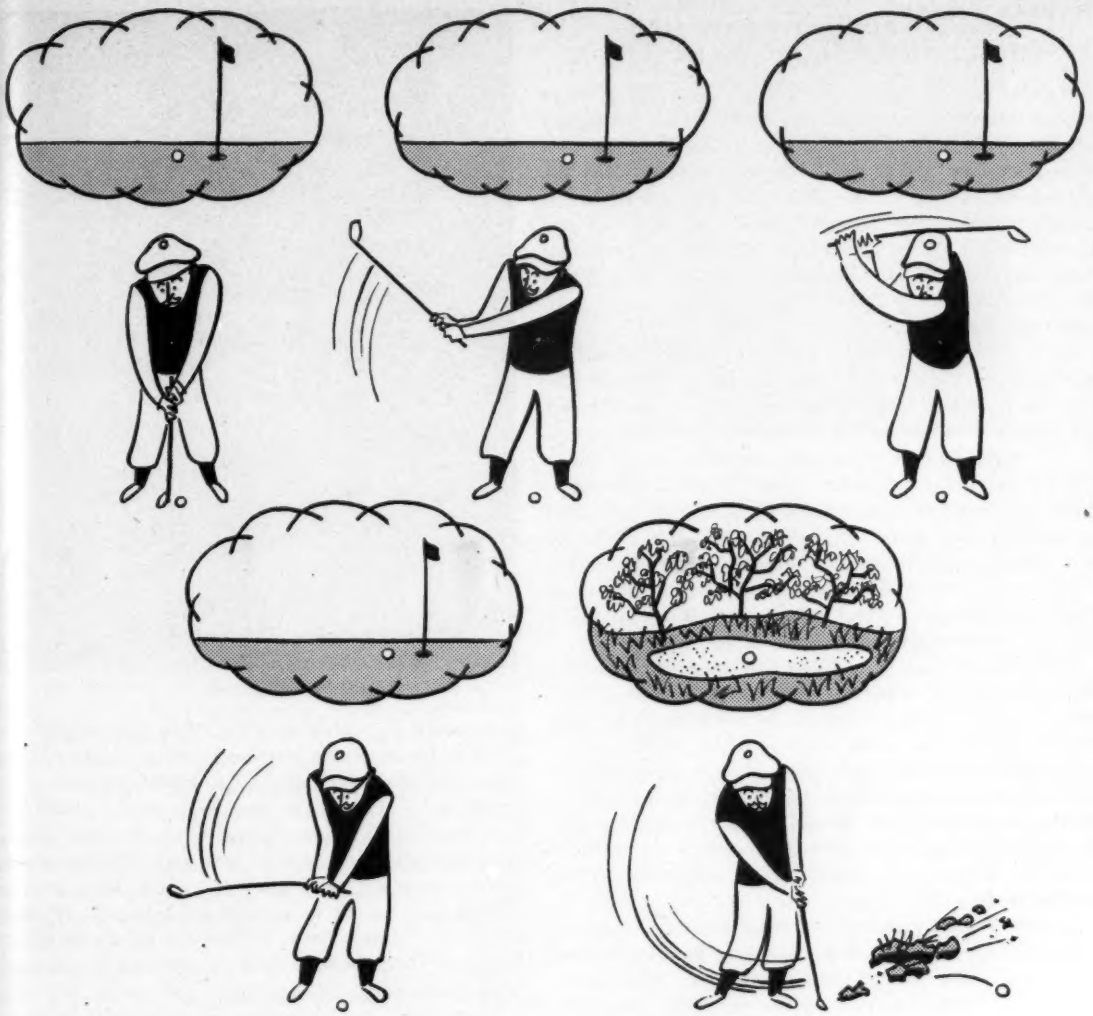
China-Cals for Chinaware! Cerami-Cals for Porcelain enamel! Specify if you want samples.



Think a stroke ahead

We got that from an old duffer we know.
He'd say, "If you want to get some place on a course
you've got to know where you want to go.
And that takes thinking ahead."

And when your production capacity hinges on
process materials like soda ash, we think it makes sense
to think ahead about a reliable source of supply.

If we can't sell you any soda ash now,
it's because we're serving our customers of record.
But we'll be glad to "think a stroke ahead" with you.
Why not get acquainted?

SODA ASH • CAUSTIC SODA • BICARBONATE OF SODA
CALCIUM CARBONATE • CALCIUM CHLORIDE • CHLORINE
HYDROGEN • DRY ICE • SYNTHETIC DETERGENTS • GLYCOLS
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Wyandotte, Michigan • *Offices in Principal Cities*

Wyandotte
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(*Continued from page* 344)

faces and redistribute strain patterns within the glass in such a manner as to reduce the likelihood of subsequent breakage. This was formerly done by sweeping the face with bushy gas flames while oxy-gas torches fused the glass-to-metal seal at the edges. It has recently been found, however, that radiant burners placed above and directed down toward the faces succeed in producing much improved strain distribution. This probably results largely from the fact that internal strains respond to patterned heat released within the glass.

Sealing "Guns" in Picture Tubes. Probably the earliest application of radiant gas heat in picture tube manufacture was where so-called electron "guns" are sealed into the narrow tube necks. The electronic mechanism is previously mounted on a glass stem assembly, with a flange slightly smaller in diameter than the glass tube neck. Although the actual seal and cut-off is usually performed by oxy-hydrogen flames, both preheating and annealing is accomplished with air-gas burners. Originally bushy flames were employed here, but small, non-impinging radiant burners were found to be so satisfactory that they are now almost universally used for the purpose.

Figure 12 shows picture tubes on a large dial machine where the sealing operation is being performed. Small radiant burners may be seen on the positions to left and right of the operator, just below shoulder level.

Baking Out TV Picture Tubes. Figure 13 shows the cross-section of a large all-glass picture tube. A phosphor coating is applied on the inside of the face B and a conductive "Aquadag" coating on the tapered inside walls A and C. These are baked at various temperatures, but usually at about 400°C.

Because glass thickness (and therefore heat capacity) is much less in the neck at A than in the face B, uniform heat application brings thin sections to temperature sooner than heavier sections. This results in uneven expansion, with frequent breakage at the seal line C. The effort to minimize this expensive "shrinkage" had resulted in long and costly ovens.

When men from the lamp industry were brought into television work, they reasoned that radiant burner patterns could here also equalize differential heating rates. After rather extensive investigations, production installations were made, and now a number of radiant gas processing units are used in this field, nearly all of which have supplanted larger electric ovens. For the same rate of production, these radiant gas units require less floor space, less energy, and much less time. Most important, "shrinkage" has been reduced substantially. Figure 14 shows TV "screen bake" equipment before installation. Figure 15 is a close-up showing radiant burner arrangement in one zone.

Fig. 18.

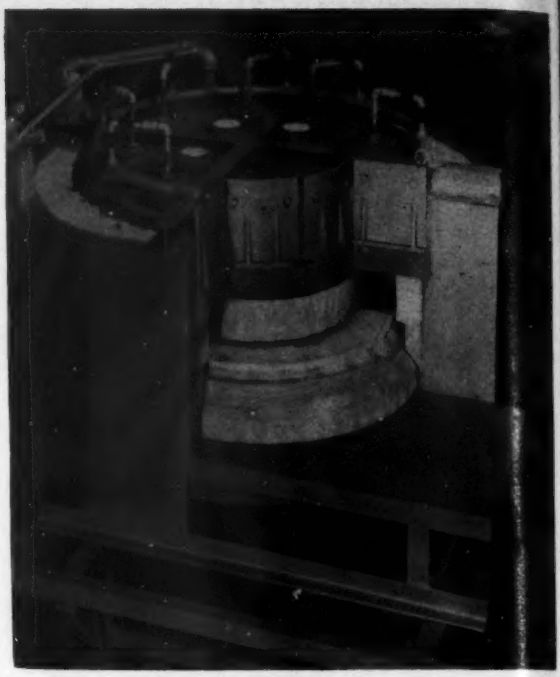

Fig. 19.

"Dropping" and Annealing Glass Panels. Many convex glass objects are formed by heating flat glass plates or discs to the softening point and permitting them to drop by gravity or by forcing them into molds with shaped plungers. In this way flat glass is converted into clock crystals, reflecting bowls for lamps, and curved automobile windows.

Traveling horizontally through the heating chamber in molds or mold rings, the glass is rapidly and uniformly heated as it passes under flat arch radiant roofs. Such a radiant roof section is illustrated in Figure 16. For a particularly difficult operation involving large and sometimes irregular shapes, one manufacturer has just installed his third radiant-roof lehr.

If metal molds with high heat storage capacity must be heated, some bottom heating may also be required. In various patterns, one midwestern plant has added hundreds of radiant burners which improve temperature in its "dropping" lehrs.

Heating Molten Glass in Feeders. A plate glass manufacturer was faced with the problem of maintaining uniform temperatures throughout a particularly long glass feeder trough. This had to be done without agitation because disturbance to the molten glass surface resulted in bubbles or "seeds" in the plate. Initial efforts to solve his problem involved the controlling and relocating of

blast type burners. He finally succeeded, however, by mounting twelve large radiant burners above and facing down upon the flowing glass. Turbulence is now so low that the glass stream itself has the appearance of a mirrored surface, and product quality is much improved.

Addition of Radiant Burners to Plate Glass Lehrs. To secure temperature uniformity across a moving strip of slowly cooling plate glass, has long been a problem. As in other glass annealing processes, the customary solution has been to use longer time cycles than otherwise necessary, allowing the material to "soak" until temperatures become uniform. In the case of plate glass cooling, this resulted in annealing lehrs hundreds of feet long.

In a successful effort to increase satisfactory production without a corresponding increase in lehr and building length, one producer recently placed inverted radiant burners over the cooling glass within his existing lehrs, in patterns which offset non-uniform heat losses, and solved the immediate problem. From these results, a radiant designed lehr is indicated as a better permanent installation.

Lens Dropping. A radiant lehr has been in operation for several years dropping lenses for sun glasses. Figure 17 shows an end-to-end section of this 35-foot lehr and the corresponding time-temperature curve which indicates the separate phases of the operation. Time in the annealing section is 7½ minutes, which is only three times the theoretical minimum. This is unusually brief.

The lehr utilizes radiant roof sections with different patterns for preheating, dropping, and annealing. Until they leave the dropping, section molds are heated also by tunnel burners beneath, and zones are separated by refractory walls suspended from above. Water coils are used in two cooling sections, while slow cooling through the critical annealing zone is controlled by radiant burner patterns of low intensity.

Exhausting Metal-Glass Tubes. Figure 18 shows a simple radiant furnace used for heating metal-to-glass electronic tubes during the exhausting process. Radiant burners are arranged to operate within a divided enclosure, in which they heat the tube at close range. Radiant energy passes through the glass and is released as heat on the internal metal parts to accelerate the driving off of absorbed gases.

Forming and Annealing of Small Blanks. In the production of watch crystals, a highly mechanized process employs a dial with open inverted radiant burners for preheating the blanks and for controlled cooling after forming. They are then transferred to a lehr heated by radiant burners from overhead. The displacement there of nozzle mixing torch flames by the radiant burner roof reduced heavy "shrinkage" to a negligible quantity.

The forming of eye-glass grinding blanks requires a comparable heating operation. Because higher heats are necessary, a rotary hearth furnace replaces the open heating dial. Figure 19 shows such a unit, with roof type radiant burners in a circle above the hearth.

Drying External Coatings. Tableware is decorated by fusing on colors of powdered low temperature glass. These are applied in a moist vehicle by the silk screen process and dried between the applications of separate colors before firing. Water tumblers being decorated are heated for predrying in less than one minute by passing them between facing rows of radiant burners, and cooled again in about two minutes by controlled air blast. This seems to be an ideal application because of the fact that radiant heat is selectively absorbed by the opaque colors in preference to the clear glass bodies.

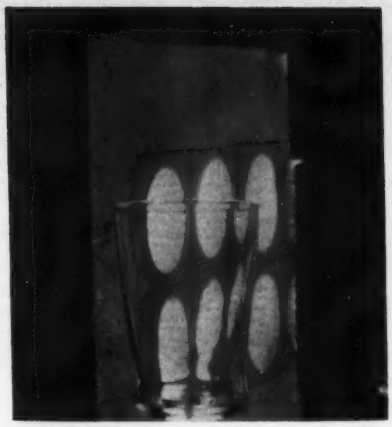

Fig. 20.

Figure 20 shows a water tumbler entering a typical radiant drier. This photograph was taken before decorations had been applied to the ware.

Conclusions

These and other accomplishments have resulted from utilizing what we have come to know as "form value". The arrangement of radiant gas heat in patterns without flame impingement, its rapid transfer and immediate partial release within the ware itself, present industry with a production tool whose usefulness has only recently been discovered. To secure its many advantages has required departure from accepted heating methods, whose continued use would have denied those advantages. New tools, new methods, and new products are only possible to those who seek with open minds.

The glass industry continues to introduce new products and to invade new markets. It is certain that development and use of better heat processes have made possible at least one new glass product for which demand still far exceeds supply. Increasing use of radiant gas heating is responsible for more and better ware—at lower cost. Acceptance of these improved heat processes is increasing the glass industry's demands for a *constant supply of uniform, quality fuel.*

To what extent will these demands be satisfied by the gas industry?

G-E X-RAY CORPORATION BECOMES DEPARTMENT OF PARENT COMPANY

General Electric X-Ray Corporation, a manufacturing affiliate of the General Electric Company, has become a department of the parent organization, it has been announced by John H. Smith. Mr. Smith, former President of the G-E X-Ray affiliate, has become General Manager of the new department.

The X-Ray Department will be part of the Apparatus Group of the firm with very little alteration being made in the activities or scope of the department.

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Glass batch gypsum—not new as a glass batch ingredient, but for the first time actually "designed" for maximum efficiency as a refining agent.

Aside from its inherent properties which in actual use have proven gypsum a most desirable product as a source of sulphate, we now offer glass batch gypsum ($CaSO_4.2H_2O$) designed in grain size to match the average size of other major raw materials.

Coupled with its natural free flowing characteristics, this special processing obviously contributes greatly toward perfect batch blending.

Other important values offered by GbG as a sulphate bearing material are: uniformity of SO_3, minimum refractory attack, minimum selenium volatilization, low iron content, dependability of supply (particularly important today), and low cost.

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DR. A. W. WISHART HEADS NEW WESTINGHOUSE GLASS UNIT

Dr. Arthur W. Wishart, former Vice President of the McKee Glass Company, has joined the Westinghouse Electric Corporation as Manager of its newly-organized Glass Manufacturing Division, Ralph C. Stuart, Vice President, has announced.

Dr. Wishart will make his headquarters temporarily at the Westinghouse glass plant at Fairmont, W. Va., which will be one of the glass factories under his direction.

A graduate from the University of Minnesota with a Bachelor of Chemistry degree and a Doctor Philosophy degree, majoring in physical chemistry, Dr. Wishart joined Corning Glass Works as a research specialist in physical chemistry. In 1941 he was appointed Manager of the Corning Glass plant in Charleroi, Pa. From 1947 to 1948, when he joined the McKee Glass Company as general superintendent, he was Technical Director for Corning's plant in Colombia, South America.

• The formation of a wholly-owned subsidiary, the Canadian Westinghouse Supply Company, to distribute products of the Canadian Westinghouse, Company, Ltd., has been announced by Herbert H. Rogge, President.

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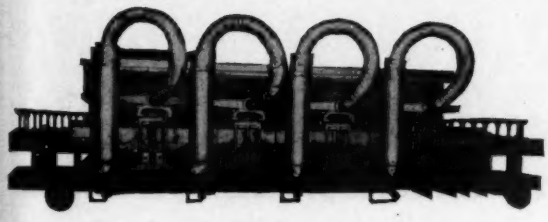
W. S. DUBOIS JOINS HARBISON-WALKER TO HEAD NEW DEPARTMENT

A Department of Market Research, the first department of its kind in the refractories industry, has been established by Harbison-Walker Refractories Company. William S. DuBois, formerly Senior Market Analyst for the Firestone Tire and Rubber Company, has joined the company to head the new department.

Mr. DuBois, a graduate of Central College, was a Graduate Fellow in Economics at Vanderbilt University. At Firestone he was associated for six years with T. G. MacGowan, a pioneer in market research.

Harbison-Walker's new Market Research Department has been created primarily with the customer's interest in mind. Among its functions will be the evaluation of customers' needs for new and existing types of refractories. When the need for a new product is established, Mr. DuBois' department will consider the means of developing it and of making it available in commercial quantities at prices the customer can afford to pay.

FIRE POLISH WITH OIL



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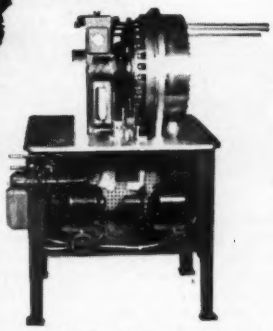

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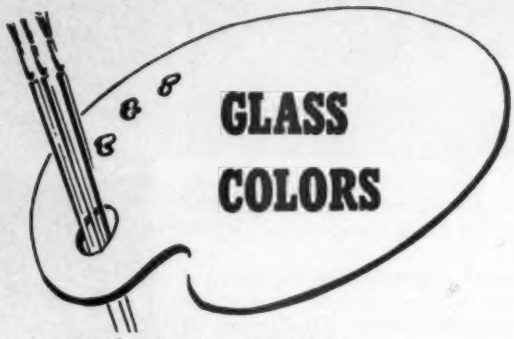

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REFRACTORIES INSTITUTE NAMES EXECUTIVE SECRETARY

The newly formed Refractories Institute has announced the appointment of Avery C. Newton as Executive Secretary.

Mr. Newton, before joining the staff of the Institute, was a member of the American Newspaper Publishers Association for seven years. He has also served as General Manager and Secretary of the City Club of New York. A graduate of the College of the City of New York, Mr. Newton taught political science for a number of years at Brooklyn College.

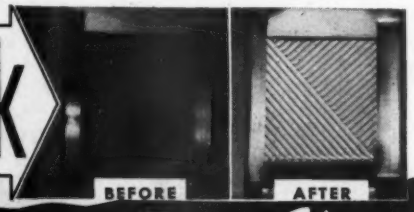
The Institute, which has been incorporated as a non-profit association for the improvement and advancement of industrial trade and consumer relations among the manufacturers of refractories products, has announced the location of its national headquarters in the First National Bank Building, Pittsburgh, Pa.

W. H. MANRING JOINS CALUMITE COMPANY

Announcement has been made by R. W. Hopkins, President of The Calumite Company, that W. H. Manring has joined the staff in the capacity of chief engineer.

A graduate from Ball State Teachers College with a B.S. degree in 1937, Mr. Manring majored in physics and chemistry. He performed graduate work and was an assistant instructor in the chemistry department from 1938 through 1940. He joined the staff of Ball Brothers Company in 1941 as an analyst and took over the duties as chief chemist for the last six years.

Look



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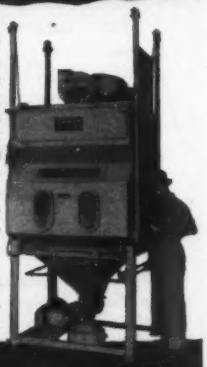

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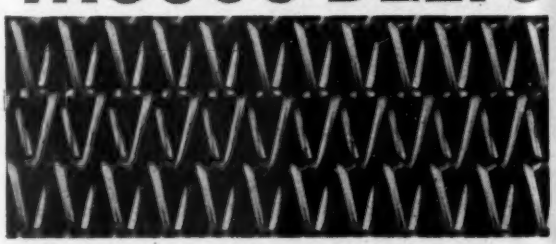

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PROGRESS AT CORNING . . .

(*Continued from page* 355)

facturing company of Argentina, Cristalerias Rigolleau of Buenos Aires. The following year a similar interest was acquired in Cia Vidraria Santa Marina of Sao Paulo, Brazil, and in 1945 in Cristalerias de Chile of Santiago, Chile. These affiliations have resulted in the successful production of Pyrex-brand baking and chemical ware in South America.

To meet the demands of the increasing Canadian trade, a plant at Leaside near Toronto, Ontario, was purchased and is being operated by Corning Glass Works of Canada, Ltd., a wholly-owned subsidiary. Leaside produces tableware and other consumer products for Corning's large Canadian market.

In 1948 and 1950 plants at Muskogee, Okla., and Albion, Mich., respectively, were completed. This year the company acquired a minority interest in Cristales Mexicanos, Mexico, and announced the building of a new plant at Danville, Kentucky, for the manufacture of glass bulbs and tubing.

The history of Corning Glass Works is replete with examples of initiative and ingenuity. Newest example of this characteristic of both management and personnel is the construction of the Corning Glass Center which was opened recently. This, designed as a receptacle of all the existent knowledge and examples of glassworking down through the ages, is expected by the company to further interest in and the search for knowledge of the most versatile substance known to industry.

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